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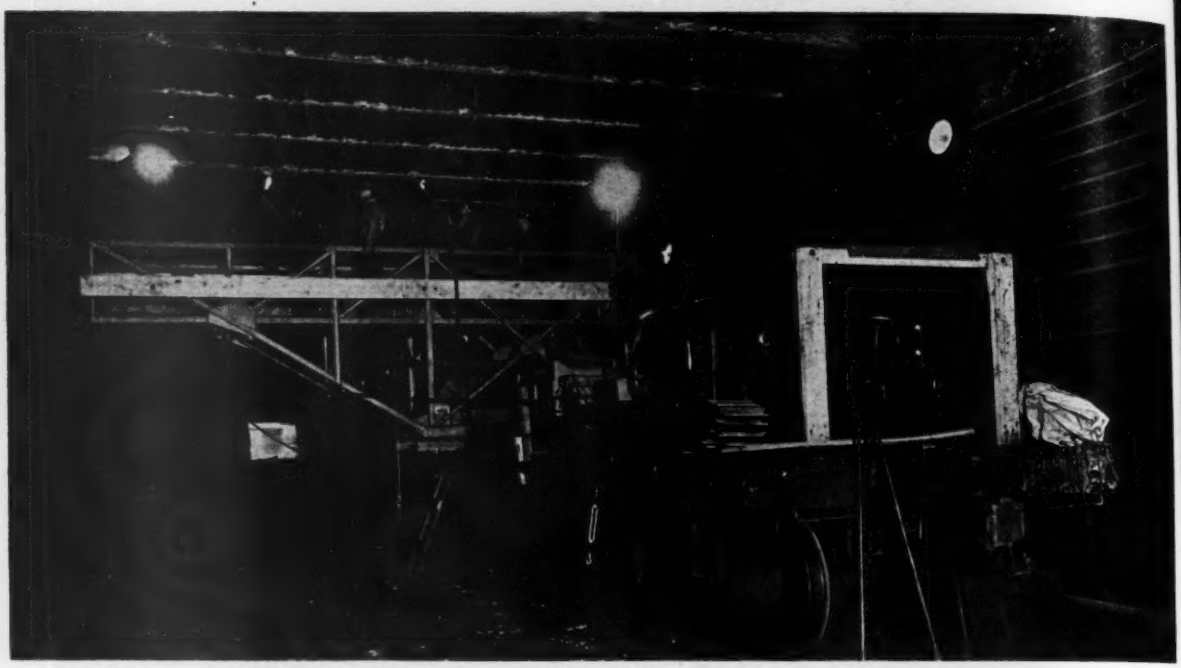

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Reclamation of the Zuiderzee

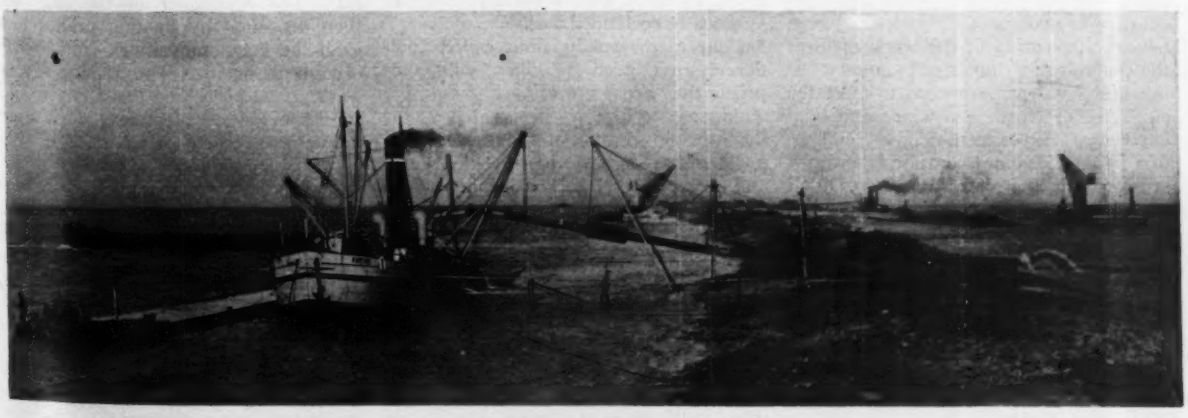
Twenty miles of massive dikes built to shut off the major part of the Zuiderzee from the North Sea—Sections of the inclosed area now being diked off and drained for agricultural purposes

By Arthur L. Shaw

Metcalf & Eddy, Consulting Engineers. Boston, Mass.

IN THE GLAMOUR of the many great American engineering undertakings which are constantly being brought to public notice through the newspapers and technical press, all involving the expenditure of fabulous sums and requiring great skill in their execution, the average American is scarcely aware that, elsewhere in the world, works are being undertaken, the conception of which is quite as ambitious, the problems of design fully as complex and the sums of money involved just as astounding as in our own country. Among these is the work now in progress in Holland to reclaim from the sea the arable lands lying at the bottom of the Zuiderzee. This extensive gulf was once a fresh-water lake before the combined forces of the lake and the North Sea shattered the low barrier separating them. The work now being undertaken is for the purpose not only of converting the Zuiderzee once more into a fresh-water body, to be called Yssel Lake, but also of diking off and reclaiming those portions of the sea bottom in which the soil is most suitable for agriculture.

It is common knowledge that the Dutch have been engaged in a struggle with the ocean since ancient times. One associates that country with the hundreds of windmills used for pumping out the drainage systems of the extensive areas which lie near or below sea level, and the legend of the Dutch boy who saved the dike by stopping a leak with his arm is familiar to all. (Unfortunately from the romantic and picturesque point of view the windmills are fast being superseded by modern pumping stations, and scientific dike construction will soon leave little opportunity for small boys to be heroes.) Prior to the present undertaking and from time to time since 1864, about 250,000 acres has been reclaimed in various parts of the Netherlands by the construction of dikes. The present



After the bank of heavy boulder clay which forms the outer section of the dike had been raised above water level, sand to form the central part of the dike was dumped behind it until the water became too shallow for barges. For the remainder dredged sand was pumped in as here shown. At the right clay is being placed on inner side of dike.

scheme, when fully completed, will add about 550,000 acres to the land area; this is approximately 7 per cent of the total area and about 10 per cent of the cultivated area of the Netherlands.

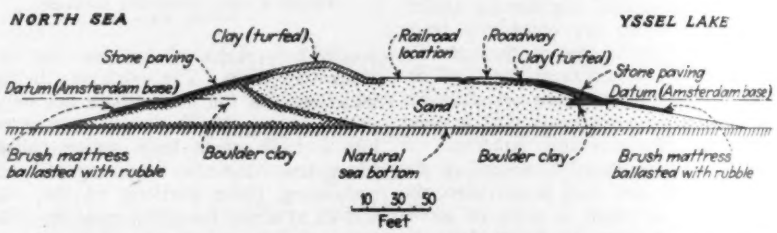
In recent years the growth of towns and the construction of roads, canals and harbors have resulted in the withdrawal of land from cultivation at the rate of about 6,000 acres per year. The probable future demands of an increasing population and the dependence of the nation upon the products of its farms and dairies have made relief imperative. The reclamation of the Zuiderzee is being undertaken to provide the needed relief.

Two great dikes, one 1½ miles long from North Holland to the island of Wieringen, and one 18½ miles long from Wieringen to Friesland, now shut off part of the Zuiderzee to form Yssel Lake. Of that area the section known as the northwest polder has been diked off and is being reclaimed. The other polders will be reclaimed as needed.

A little less than a century ago the desirability of inclosing and reclaiming the Zuiderzee was recognized, but the accomplishment of the scheme was beset by apparently insurmountable obstacles, until modern advances in the science of hydraulic engineering and in the equipment and technique of dredging operations gave the Dutch engineers courage to undertake the task; and even now the execution of the work requires the exercise of no small amount of ingenuity and perseverance to meet the challenge of North Sea winds and tidal currents. Experiments upon models, first in the German hydraulic laboratory at Karlsruhe and later at the new Dutch laboratory in Delft, have played an important part in the design of the works; in addition, intricate calculations were necessary to forecast the influence of the proposed works upon tidal currents and, conversely, the effect of the altered tidal conditions upon the new works. So far as construction has proceeded, the observed phenomena have confirmed the predictions closely.

The extensive use of heavy construction equipment and machinery is noteworthy, in view of the popular impression that hand labor is the main reliance in European construction. Special devices for the excavation of canals and drainage ditches and for the handling of materials for the dikes have been developed to a remarkable degree.

A general plan of the undertaking is shown herewith. The inclosing barrier, now under construction, extends from the mainland of North Holland 1½ miles to the westerly end of the former island of Wieringen, and from the easterly end of Wieringen 18½ miles across the Zuiderzee to the coast of the province of Friesland. This dike is of heavy proportions to take the brunt of North Sea storm and tide, permitting the use of a lighter and less expensive type of dike to inclose the areas which are to be reclaimed for agricultural purposes within the main barrier. On this long dam will run a highway and a double-track railway, which are expected to be of great advantage to the country by improving communication between the northern provinces. Through it, by means of two sets of locks, will pass the North Sea fishing fleets and some of the smaller coastwise ships which now enter Dutch ports through the Zuiderzee; and in it are constructed at two locations great batteries of sluices to carry off, at low tide, the waters poured into Yssel Lake by the rivers Yssel (a mouth of the Rhine) and Vecht and numerous other smaller streams, as well as the water pumped from existing and proposed drainage systems in reclaimed areas.



The two main dikes shutting off the Zuiderzee are of very massive construction to withstand attacks from the North Sea.

Four major subdivisions called "polders," surrounded by dikes, will comprise the areas reclaimed from the Zuiderzee. They are designated as the northwest, southwest, southeast and northeast polders, each to be developed and operated as a unit, with independent dikes, drainage systems and pumping stations. Within each polder will be further subdivisions, each of which will be served by a drainage system established at a level determined by the topography. The reclaimed land will be systematically planned so that roads, villages, canals and farms shall bear the most advantageous relationship to each other and so that as much as possible of the new areas may be profitably employed. Thus far only the smallest, or northwest, polder has been constructed, the dike and pumping station for this development having been completed late in 1929 and the unwatering having been accomplished during 1930.

Main inclosing dam

The shorter section of the dam, joining the island of Wieringen with the mainland of North Holland, was finished in 1924; and the 18½-mile stretch across the Zuiderzee, having been begun in 1927, has now been closed above water level and is in process of completion. The very heavy section shown below has been adopted, with its crest from 20 to 25 ft. (varying according to the exposure) above the Amsterdam datum to withstand the highest expected waves, superimposed upon the highest anticipated tide, although the simultaneous occurrence of these maxima is only remotely probable. Bitter experience has taught the Dutch engineers that overtopping by waves is the most frequent cause of dike failures, and they have wisely decided to take no chances with this major structure. The bottom lies from 8 to 16 ft. below the datum for the greater part of the length of the dam, increasing for short distances across the channels to a maximum which was originally about 40 ft., but which was increased in places to over 50 ft. by scour due to high velocities as the channels were narrowed during construction.

The boulder clay core, or nucleus, was placed by dumping the material through the bottoms of specially constructed scows, until it was no longer possible to float the scows over the accumulated fill. The remainder of the core was then deposited by floating cranes with grab buckets, unloading from scows brought alongside. The backing of sand was carried up behind the clay core in a similar manner, except that when direct dumping is no longer possible the barges were unloaded by suction dredging methods, pumping the sand through pipes and discharging it in place.

The clay, which was dredged from selected points on the bottom of the Zuiderzee, is extremely tenacious, sticky, and resistant to scour. It was placed, as a rule, within a short time after it was dredged, while still wet and plastic, so that even when placed above water no special treatment such as puddling or mixing was necessary.

The slopes of 1 on 4 for boulder clay and 1 on 6 for sand are practically the natural slopes which these materials assume when placed under water. Above water level the clay blanket was placed by buckets, or endless belts, carried on long booms reaching far up the sloping bank from floats or barges specially rigged to facilitate the unloading of the scows.

Stone paving protects the slopes from about 1 ft. below the datum to about 16 ft. above on the seaward face and about 11 ft. above on the lake side. Both basalt and limestone blocks are used for this paving. The former present a novel appearance on the slopes due to the hexagonal shape of the blocks, which roughly nest together without continuous joints. The basalt is obtained from quarries along the Rhine in Germany, where it occurs in closely packed vertical shafts or columns, which can be readily thrown down and broken up into the desired lengths. The limestone, quarried on the Meuse in France, comes in roughly square blocks, which are laid in parallel courses. Price is the factor which determines whether basalt or limestone shall be used in a given section of the work.

Below the stone paving and down to about 8 ft. below datum, the slopes are protected by brush mattresses, sunk into place and covered with a layer of rough stone rubble.

The closure of the two main channels, "Middelgronden" and "Vlieter," were the last major operations in constructing the dam, the entire tidal flows being then concentrated at these channels. Studies conducted in the hydraulic laboratory have been of inestimable value in predicting the distribution of velocities and in determining the order of construction best suited to the task of accomplishing the closure with success and a minimum of loss of material due to scour.

The first step undertaken was the filling of the channels up to about 10 ft. below low water with "sill-dams" of boulder clay, covered by heavy brush mattresses, weighted with large stones of a size calculated to withstand the anticipated velocities before the superstructure of the dam is added. The waterways remaining above the sills were estimated to be adequate for the tidal flows, and the presence of deep water at either side of the sills was found to be advantageous in arresting scour, which might otherwise damage them.

Experience has shown that the boulder clay at the ends of fills as they approach a closure can withstand a velocity as high as 12 or 13 ft. per second without serious scour. Velocities at the sides of the channels, due to normal tides in the early summer, were not expected to exceed this, unless an unusual storm should intervene. It was therefore intended to make the final closure in the early summer of 1932, to avoid if possible the extreme velocities which would accompany severe storm tides.

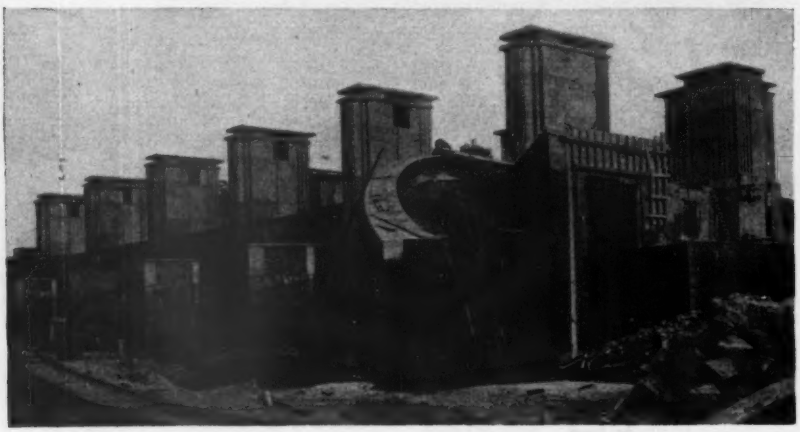
In 1931, however, divers found that the galvanized iron wire with which the brush mattresses used in the sill dams were bound was seriously corroded, particularly in the Middelgronden channel, where the wire had been sub-

Heavy mattresses of brush ballasted with stone were sunk below the level of low water on both sides of the main dike to protect it from scour. Stone brought in on scows was unloaded and passed to place by hand.

Shafts of basalt, as shown here, were used extensively for paving slopes exposed to wave action. In this background clay is being delivered for topping out the dike.

merged since 1929. Work on the closure of this channel was therefore started ahead of schedule and vigorously pressed to completion in November, 1931, in advance of the winter storm tides. The Vlieter channel remained to be closed during the year 1932.

A total of 25 suiceways will permit the discharge of the excess waters of Yssel Lake into the North Sea. Fifteen of these, in three batteries of five each, are located at Den Oever, near the westerly end of the dam, and two batteries of five each are situated on the Kornwerderzand, about 2½ miles from the coast of Friesland. At both of these places earth cofferdams were built to provide inclosures within which the sluices and ship locks could be built in the dry.



Sluices through the main dikes are of massive concrete construction. The cutwaters are of dressed granite, and the sluiceway walls are faced with basalt block laid up in advance of the concrete to act as forms.

Each sluiceway is about 40 ft. in width and 165 ft. in length, with gate sills nearly 15 ft. below Amsterdam base. Each has a pair of mitered tide gates of steel, which fold back into recesses in the sides, and two vertical sliding sluice gates, which can be hoisted up into the superstructures provided.

The cutwater buttresses and the gate sills and slots are faced with granite. The remainder of the sluiceway walls are faced with dressed basalt and the floors are paved with brick. The use of wooden forms was minimized by carrying up the stone masonry facing in advance of placing the mass concrete that comprises the bulk of the wall structure. This method of constructing mass concrete walls is common practice in Europe and is used to excellent advantage in England in the construction of hydraulic works for sewage treatment and water purification. In such structures the masonry facing (commonly a blue vitrified brick in England) seems to have solved the problem of protecting concrete from the disintegration which has been so troublesome in exposed concrete surfaces everywhere.

The bottoms of the channels approaching the sluiceways are protected with brush mattresses, woven in place and covered with rubble. The side slopes are paved with limestone or basalt laid over straw thatching. The plaiting of thatch, the weaving of brush mattresses and the laying of paving are laborious hand operations for which mechanical devices do not appear to have been developed. The availability of relatively inexpensive labor is probably the determining factor in the choice of this class of channel protection as against the types being developed in the United States, such as flexible concrete mats that permit considerable use of machinery in manufacture and placing.

The sluices at the Kornwerderzand are built on pile foundations containing about 12,000 piles. At Den Oever, however, the boulder clay subsoil is believed to be adequate without piles, and each unit of five sluices is built on a monolithic reinforced-concrete mat, about 290x165 ft. in plan and 4 ft. 3 in. thick.

Ship locks

At Den Oever a lock, 46 ft. wide and 465 ft. long, will permit the passage through the dam of a 2,000-ton ship with a tug. On Kornwerderzand a similar lock is provided, as well as a smaller one, 29.5 ft. wide and 230 ft. long, for 600-ton boats. A small drydock is provided at each place for convenience in overhauling the lock gates.

Swing bridges are provided over the seaward approaches of the locks to carry railroad and highway traffic. Waiting basins between the locks and the bridges will permit uninterrupted lockage when the bridges are closed.

The locks were put into service before the final closure of the main dam was commenced, in order to provide for shipping while the filling of the channels was in progress.

Yssel Lake

The area of the Zuiderzee within the inclosing barrier is approximately 820,000 acres. Of this area about 270,000 acres will constitute Yssel Lake after the reclamation of 550,000 acres consisting of those shallower parts which are best adapted for the purpose from the standpoint of accessibility as well as desirability of the soil for agriculture. The unreclaimed lake area will be reserved as a storage basin in which to store the inflow from the tributary streams during periods when the level of the North Sea is too high to permit discharge through the sluices. The lake will be held ordinarily about 16 in. below Amsterdam datum, and it is not expected to rise more than 4 ft. above this level under the most unfavorable conditions, when the rivers are in flood and the North Sea is held at high levels for as long as three or four days at a time, due to unusually high tides and storms.

The rivers feeding Yssel Lake transport large quantities of silt and suspended matter, much of which will settle out in the proposed lake. The areas reserved for the lake, however, cover the deeper parts of the Zuiderzee, and there is believed to be sufficient capacity for the deposits of a great many years. It is conceivable that this alluvial material may be of sufficient value for enriching the sandy portions of the reclaimed areas to justify dredging for this purpose when deposits become objectionably deep.

As an economic asset, much is hoped for the Yssel Lake. By the exclusion of both periodic and abnormal high tides of the North Sea, the maintenance of dikes adjacent to the lake will be made easier and the menace of occasional inundations, to which some of the smaller towns along the coast have been subjected in the past, will be removed. The substantially constant level of the proposed lake will make navigating conditions safer, and the presence of a large body of fresh water will relieve the shortage which now exists during the summer months in some sections where fresh water is much needed for cattle and for agricultural and industrial purposes. There is also a possibility of establishing a profitable fresh-water fishing industry in the Yssel Lake, when the salt water finally shall have been replaced with fresh.

The ultimate complete replacement of salt water with fresh is problematical in view of experiences elsewhere, as in the Charles River Basin at Boston, Mass., where, after some 20 years a stratum of brackish water still persists at the bottom.

The polders

The areas to be reclaimed in the several polders are as follows:

Northwest polder	50,000 acres
Northeast polder	135,000 acres
Southeast polder	230,000 acres
Southwest polder	135,000 acres
Total	550,000 acres

Thus far only the northwest polder, called the Wieringenmeer, has been diked off, and this area was pumped out during 1930. The necessary main drains and canals were dredged for the most part during the progress of the embankment construction. This method not only is less expensive than dredging after unwatering but aids the latter process by facilitating the flow of water to the pumps. It also permits the early completion of the lateral drains, which will speed the time when the land can be put under cultivation.

An experimental polder of about 100 acres was constructed in 1927. There as well as in the Wieringenmeer scientific agricultural studies are being conducted to determine the way in which the land can be made suitable for agriculture most rapidly, after its long submersion in salt water, and the most advantageous crops for cultivation during the transition period. Experiments have also been made with various types of drainage systems, to determine the preferable spacing of ditches, the practicability of underdrains and the like. The results obtained have indicated that it is possible to put much of the reclaimed land under profitable cultivation with certain crops within a year or two after unwatering, which is considerably sooner than had been expected.

Pumping stations

Two pumping stations are used to remove the water drained from the northwest polder. One is electric motor-driven and is located at Medemblik, at the southerly end of the polder. The other is situated at Den Oever, near the northerly end, and is powered with diesel engines. Both are equipped with centrifugal pumps. They are widely separated and have different sources of power to give assurance of continuity of pumping in the event of an emergency at either plant. No pumping will be done by windmills, not only because of the large capacities required, but because this method has been found uneconomical due to excessive cost of maintenance, which has resulted in the extensive replacement of windmill pumps with electric or diesel-driven units in many parts of Holland, although windmill structures are often retained for landscape purposes.

The station at Medemblik with its three vertical-shaft units is suggestive of a conventional type of hydro-electric generating station. Each of its units has a capacity of 230 sec.-ft. against a head of 20 ft. at the full-load speed of 107 r.p.m. The 1,000-hp. motors can be run at reduced speed to vary the rate of pump discharge.

The Den Oever station has two horizontal-shaft direct-connected units, with space for a third. Each pump, with a capacity of 163 sec.-ft. against 17.4-ft. head, is driven by a 6-cylinder diesel engine of 600 hp.

The normal combined capacity of the two stations is over 1,000 sec.-ft. This was increased to about 1,600 sec.-ft. during the first part of the unwatering period, due to the decreased pumping head and the use of special temporary pump impellers, thus hastening the initial removal of salt water from the polder.

At both stations each pump will ordinarily handle the water drained from a certain area, or group of terraces, thus taking advantage of differences in pumping lift, but the arrangement of gates and conduits permits complete flexibility of interconnection if desired.

It is interesting to compare the six months' time required to unwater the 50,000 acres of the Wieringenmeer with the span of more than four years consumed in pumping out the Haarlemmermeer with an area of 45,000 acres, in 1848-1852, with the steam-pumping plants of that period.

Estimated cost

In 1924 the estimated cost of the complete proposed works was about $220,000,000, including interest during the transition period until the land has reached its normal value, and allowing credit for the value of the output during that period. The actual costs of the dike and drainage work done in reclaiming the northwest polder and of the work thus far done on the main inclosing dam have exceeded the estimates by roughly 50 per cent.

At the time of the 1924 estimates it was anticipated that upwards of $250,000,000 would be realized from the sale of reclaimed land and from betterments. There has been, of course, no opportunity to check the accuracy of this estimate.

On the other hand, as the agricultural experiments indicate that the land can be brought into full use considerably earlier than was expected, interest charges during the transition period will be materially less than anticipated. It seems certain, however, that the undertaking as a whole will be considerably more costly than was originally estimated.

Revised Method of Averaging Oregon Precipitation Figures

By L. L. Harrold

Junior Engineer, U. S. Geological Survey, Washington, D. C.

BEGINNING with January, 1931, the Oregon section of the U. S. Weather Bureau changed its method of computing mean monthly and annual precipitation and temperature records for the state. Under the old method of computation the state average was the arithmetic mean of all the stations in the state having ten or more years of records. The revised method consists of computing the arithmetic mean of thirteen section averages.

Precipitation and temperature records for Oregon have been and are now published on the basis of three areas—the eastern or arid division, the western or humid division and the state as a whole. The old method of computing the division averages was to take the arithmetic mean of all the stations in that division having ten or more years of record, and the state average was the arithmetic mean of all those stations. The state is now divided into thirteen nearly equal sections, four in the western division and nine in the eastern division. The average precipitation and temperature is computed for each of these sections by averaging all stations having ten or more years of record. The arithmetic mean of the thirteen section averages now gives the state average. The arithmetic mean of the averages for the nine eastern sections gives the eastern division average, and the arithmetic mean of the averages for the four western sections gives the western division average. Annual and monthly averages for precipitation and temperature are now published on this basis in all Weather Bureau reports, beginning with 1931.

The need for this revision has long been apparent, owing to the unbalanced condition of the state with respect to the density of rainfall, character of storm travel and topography, all of which resulted in one-third of the state area being extremely wet and the remaining two-thirds dry. In addition to this unbalanced condition, the western division had until recent years a greater number of precipitation stations than the eastern division, which is twice as large. For this reason the arithmetic mean of all the stations in the state has been higher than the actual average.

As a result of the change, the reported western division normal rainfall has been increased from 49.23 to 51.36 in. The reported eastern division normal precipitation has been decreased from 15.77 to 14.49 in. The state normal precipitation has been decreased from 35.00 to 25.78 in. The change in the state annual average has been most noticeable during the early part of the record where the maximum decrease was 22 in.

The Oregon section of the U. S. Weather Bureau is under the direction of Edward L. Wells. A similar method of average computation was adopted in 1927 by M. B. Summers, in charge of the Washington section of the Weather Bureau.

Foundation Design for an Elevated Tank

Girder continuity and large number of heavily loaded columns in new 1½-m.g. radial-cone bottom tank at Evanston, Ill., make foundation design controlling—Tank bottom and girders are welded

By M. B. Meyer
Structural Engineer, Building Department Evanston, Ill.

THE NEW 1½-million-gallon radial-cone bottom elevated tank recently put in service in Evanston, Ill., to correct pressure deficiencies in the water system in the southwestern part of the city, is 104 ft. in diameter and 92 ft. high to the bottom, and has a total range between the upper and lower water levels of 25 ft. Tanks of this type, with bottoms almost flat and consisting of a number of radial troughs, each a half section of a cone, have been built in four other locations in the country in the past two years. They present some new problems of design inasmuch as the girders carrying the bottom are supported on rows of columns in lines radiating outward from the riser, which also acts as a girder support. The girders are designed to be continuous. Also the bottom plates of the tank are considered as a portion of the top chord of the girders. In the Evanston tank these plates are welded to the girders (Fig. 1), which are also shop-fabricated by welding. As continuous girders require rigid foundations, a careful program of foundation exploration was laid out and followed, and tests were made on the completed tank to determine how well the completed foundations served the continuous girders.

Fig. 1—Welding trough-shaped bottom plates to continuous radial girders in new 1½-m.g. elevated tank in Evanston, Ill. Continuous girders increase importance of foundation design.

Foundation construction

As a first step, test borings were made in the foundation area. They revealed at El. 3 considerable blue clay, extending to a depth of about 25 ft., immediately followed by gravel and sand mixed with clay. Such formations were obviously inferior to support the heavy tank load on floating spread footings. The efficiency of piles were next examined, test piles being driven in lengths of 30, 45 and 55 ft. near the boring holes. These tests indicated that the structure should be carried on piles and that the piles should be driven to a depth of about 70 ft. if they were to be satisfactory. Inasmuch as the city requires that all wood piles be cut off 1 ft. below city datum, the butt end of the pile had to be about 16 ft. below natural ground level. This made is possible to use piles about 55 ft. long. It was originally planned to excavate each column footing separately, but cost estimates proved that it was more economical to excavate the entire area of 104 ft. in diameter to a depth of 16 ft.

One month was required to drive the 393 wood piles supporting the 49 concrete piers, including the riser pipe pier. On each column footing (8x6 ft. in plan) the load was about 410,000 lb. With eight piles per footing, the load per pile was thus 51,000 lb. Large piles were used because the top 20 ft. was in a semi-soft material offering little lateral resistance; the large diameter compensated for slenderness ratio effects.

In general, the foundation structure is similar to a wagon wheel—that is, the hub of the wheel is represented by the center pier, which supports the 10-ft. rise pipe, and the outer struts represent the rim of the wheel, while the radial struts represent the spokes (Fig. 2). The design was carried out in accordance with this assumption.

All column footings were reinforced with steel bars placed at right angles to one another. Vertical dowels were provided in the footings to project into the column. It was planned to pour the entire foundation monolithically, but due to the large volume this was found impracticable. However, the columns in one line and their radiating strut were constructed in one pour. All concrete columns in the substructure were designed for lateral wind moment and outward radial expansion as well as for direct column load. The circumferential struts were placed 4 ft. below the top of the concrete pier columns as a protection against frost action. In general, three radial struts and their respective columns were poured in a working day.

Superstructure

In erecting the superstructure all column base plates were welded to the columns. Also, all bottom plates were welded to the radial girders, which were shop-fabricated by welding and welded

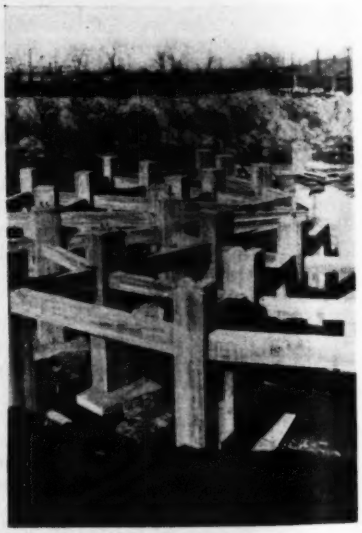


Fig. 2—Foundation structure consists of 49 footings carrying 48 stub columns and a center riser-pipe pier. Radial and circumferential struts tie columns and center pier together. Each footing is placed on eight wood piles to reduce settlement to a minimum.

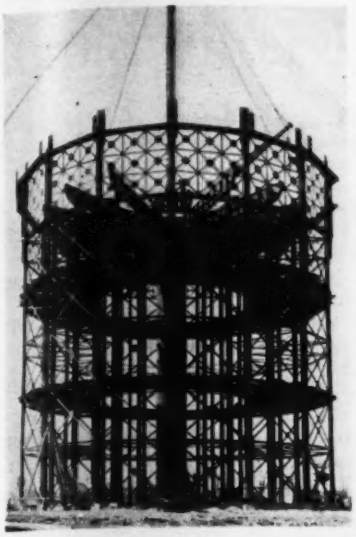


Fig. 3—Tower, riser and welded radial girders in place, ready for tank construction.

in the field to the supporting columns. Fig. 3 shows the erection of the steel columns and the sixteen girders. The design spaced the columns so that theoretically the water loads on them would be equal.

The continuous girders (Fig. 4), 41 ft. long, are made up of a 60x⅜-in. web plate, an upper flange consisting of a 2½x2½-in. bar and a lower flange consisting of a 12⅜x½-in. plate. Inasmuch as the radial-cone bottom plates are welded directly to the upper flange of the girder, the assumption was made that these plates are an integral part of the upper flange section and therefore an element of the girder.

Foundation settlement

One of the necessities in designing for continuity is to assume that there is no settlement of any appreciable amount in the supports. The ideal condition of no settlement whatever seldom obtains in actual practice, so that, to check settlement and consequent lack of alignment of supports in the Evanston tank, precise levels were taken of the base plates in several rows of columns and the center pier. Initial readings were taken with the tank empty. After the tank was filled with water a new set of levels was run. The average settlement of all the piers after the water had been in the tank for 100 hours was about ¼ in. The tank was emptied, and after 72 hours a similar series of precise level readings showed complete recovery of each pier. The relative settlement of each column footing with respect to the plane of the tank showed unsymmetrical changes: col. 2 had settled 0.1596 in., col. 3, 0.1956 in., and col. 1, the riser pipe, 0.2736 in. Thus col. 3 deflected 0.036 in. more, and col. 1 deflected 0.114 in. more than col. 2.

Simultaneously as precise levels were taken on the individual pier foundations, strain-gage readings were taken on the respective steel columns with a 20-in. strain gage. Four gage lines were located on each post at points 1 in. from the outer flange edge of the columns. These readings also showed full recovery of the column when the tank was emptied.

The design, as stated, spaced columns 3 and 2 so that the load on each would theoretically be the same. The strain-gage readings showed that col. 2 received 11 per cent larger load than col. 3, which apparently can be attributed to the difference in alignment caused by the column settlement. Fig. 5 shows the change in the distribution of the bending moment of the loaded continuous girder, assuming first that the three column supports remain in the same plane, and second that they have moved out of the assumed plane. The curves indicate that the distribution of stresses in the continuous girder are far different than one would assume, and that the stresses may slightly increase at one section of the girder and decrease at another section. They also show that the assumed reaction of col. 3 has decreased 10 per cent, while that of col. 2 has increased 7 per cent.

The results of these tests emphasize that for this type of tank a well-designed substructure is necessary, including correctly proportioned column footings and proper spacing and penetration of the piles, to the end that settlement of the foundation may be as uniform and as small as possible.

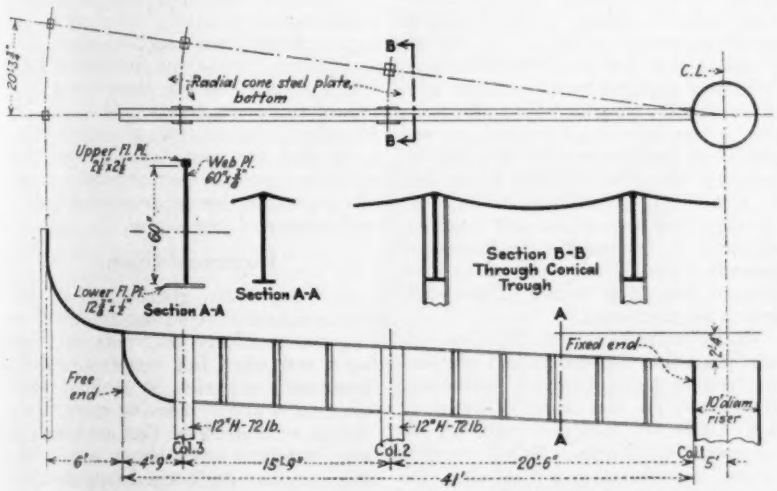
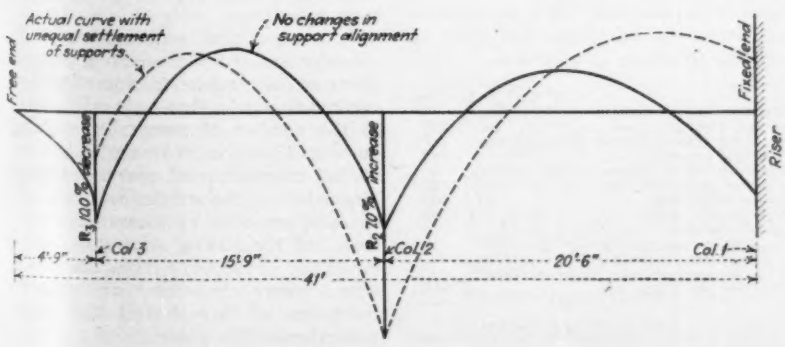


Fig. 4 (above)—Radial girders, completely shop-welded, are designed as continuous and welded to supports. Bottom plates are welded to the girders and considered an integral element of the top chord.

Fig. 5 (below) — Theoretical and actual bending-moment curves of a continuous radial girder, showing effect of foundation settlement on column reactions, which in the design were assumed equal.



American Standard Forms for Concrete Construction Floors

A new "American Standard on Forms for Concrete Joist Construction Floors (A48-1932)" has been approved by the American Standards Association. It covers the main dimensions of removable and permanent forms, pans or domes made of wood, steel or other material used in concrete-ribbed floor construction.

The standard is a revision of "Simplified Practice Recommendation R87-31."

The new standard was submitted to the American Standards Association by the Concrete Reinforcing Steel Institute and the National Bureau of Standards as an existing standard. It may be purchased from ASA at 5c. per copy.

Construction Neglects Safety and Pays for It

EXPENDITURES because of accidents were counted as one of the major wastes of construction by the committee reporting on this subject at the National Conference on Construction held at Washington, D. C., on Oct. 12-14. A definite charge was made of lack of an accident-prevention attitude of mind by constructors. An abstract of the report follows. —EDITOR.

BUILDING accidents are a very large item in the cost of building operations. The number of fatalities is increasing, and the less serious injuries are likewise growing in number. The economic results are very serious. On the basis of $7,000,000,000 of new construction a year, allowing 40 per cent as the cost of labor and applying the average compensation-insurance cost per $100 of payroll and the average paid-claim ratio, it is estimated that the direct losses for which employees are compensated amount to more than $54,000,000.

Analyses of industrial accidents show that the indirect loss to the insurer is four times the direct loss. The indirect losses in the contracting field may be in some such ratio; certain checks on construction accidents indicate the ratio to be even higher. Despite the fact that a contractor is insured against accidents, he still suffers a greater loss through indirect causes—loss of employees' time, stoppage of work, shifting of men and foremen, investigating the accidents, loss in morale, repairing property damage, minor accidents that no compensation is paid on, etc.—equal to perhaps four times the cost of his accidents to the insurance company. Including these incidental accident costs (assumed four times the direct costs), the construction industry bears an annual accident-cost burden (based on 1928 totals) of more than a quarter of a billion dollars.

Causes of accidents

Various conditions have been held accountable for this high accident cost—high speed, greater production per man, the increasing use of explosives and machinery, unenforced legislation, the absence of complete safety codes, lack of interest, skill or experience, the shortcomings of irresponsible contractors and improper organization. All these things and more, individually and collectively, play a part, but in none of them do we find a complete and satisfactory answer.

Construction executives, on the whole, are not uninterested in accident prevention; on the contrary, they are keenly desirous of producing results. Contractors and their employees, as a whole, are an alert, keen-minded group of men. Codes, rules and laws are valuable, but they provide no major remedy. Those that we now have (incomplete as they are), if enforced, should suffice to produce safer conditions, provided the remedy lay in that direction.

Modern high-speed mechnical devices in the form of heavy-duty derricks, material hoists, power shovels, trench diggers, drills, mucking machines and tunnel shields, together with the use of high-power explosives, introduce new and more serious hazards. Moreover, a greater number of units of material are handled per employee. In other words, the production exposure per man-hour is greater because of the introduction of modern mechanical devices; yet it is, in some cases at least, partly balanced by the elimination of hand labor with its hazards to a larger number of workmen.

The trouble is that progress in mechanical methods has not been attended by a corresponding development in supervisory methods. The construction industry does not yet know the real causes of the accidents that are occurring, notwithstanding that knowledge of these causes is available. It has no practical plan for accident prevention. It is now engaged in an excellent educational safety program, but at the same time it does less actual accident-prevention work than some other branches of industry—less than the steel plants, less than the textile, food and clothing industries, and the mines and quarries, although it conducts a business, the hazards of which are equal to or even greater than those of any of the other industries mentioned.

Faulty instruction, lax discipline, unsafe practices, inattention and physical and mental impairment or inefficiency are some of the *real causes* of construction accidents, and they produce 88 per cent of all injuries. It is interesting to note that they are, in each case, the very things that construction executives are now able to control (and do control) in so far as they seriously and directly affect the quality, speed and volume of the work.

Engineers of a leading insurance company have analyzed 5,000 construction accidents and have classified them according to causes as follows:

	No. of Injuries
Faulty instruction, no instruction and not enforced	2,302
Lack of concentration, inattention	780
Unsafe practices	747
Inability of employee, inexperience, poor judgment, lack of skill	321
Poor discipline	200
Physically unfit	85
Mentally unfit	15
Improper mechanical or physical conditions, lack of guards, defects in equipment, poor housekeeping, improper planning	550
	5,000

The remedy consists in the systematic and orderly merging of accident-prevention work with construction supervisory routine on a basis of facts recorded in a more intimate, regular and effective manner.

To accomplish this, it is necessary to have a knowledge of the real causes of injuries and a determination to get results, which is as well founded as is the determination to produce good construction in the estimated time and at a fair profit.

Safety practices should be made a part of the task of foremen and superintendents, not simply in the passive role of reporting accidents but in the active role of preventing them.

Safety planning should start in the office of the engineer and architect. Erection plans and devices should be designed with it in mind. Foremen and superintendents should be rated with some reference to their safety records. They can prevent accidents by making the workers safety-conscious.

Contractors will never succeed in solving the problem if they are content merely with general educational activities and are satisfied to hold general conferences; or if they continue to accept accident types (such as slips, falls, and falling objects) as fundamental accident causes and are complacent with regard to having losses paid by the insurance carrier or from a reserve fund; *or if they are unwilling to admit that accident control is just as vitally a part of the construction program as is quality and volume of production.*

Recommendations

It is urged that general and subcontractors carefully consider the effect on costs of accidents occurring on their work and offer full cooperation with insurance companies in making work safe as a means of reducing costs.

It is recommended that meetings of superintendents and foremen with insurance company engineers be encouraged, along with the continuance and extension of safety campaigns, poster displays and other accident-prevention measures.

It is suggested that owners urge on contractors the carrying of insurance involving proper supervision by insurance companies.

It is urged that insurance companies consider means for eliminating any duplication of inspection operations on construction jobs that may exist owing to the number of companies covering one job. Combined coverage by builders for all subcontractual operations for a single job, or the standardization of inspection practices by insurance companies, and the making of mutual agreements for cooperative inspection where two or more companies have risks on the same job are devices that might work toward this goal.

Rapid Filter Hydraulics Disclosed by Experiments

Detroit investigators evaluate the loss of head resulting from the passage of clean water through a bed of graded sand in terms of the physical factors involved: depth, rate, size, porosity and temperature

THE EXPERIMENTS reported in the following article were undertaken as the first step in a study of the factors determining the length of filter run in water purification plants. From experimental data a formula is derived which is of value in enabling the designing engineer to compute accurately that part of the initial loss of head that is due to the sand bed itself. Clogging rates do not enter into the present discussion as clear water was used throughout the series of tests. The effect of coagulated turbidity in increasing the hydraulic loss as the filter run proceeds is to be the subject of future investigations. —EDITOR.

THE HYDRAULIC loss of head involved in the passage of clear water through a bed of graded filter sand has been studied by two Detroit investigators and accurately evaluated in terms of sand size and shape, depth of filter bed and temperature of water. The results of the study were presented in a paper by Roberts Hulbert and Douglas Feben, senior chemists of the Detroit Department of Water Supply, at the meeting of the Central States Section of the American Water Works Association at Erie, Pa., Sept. 22, 1932. The requisite data for the formulation were obtained from a large number of accurate measurements made under carefully controlled experimental conditions, using apparatus specially designed and built for the purpose.

The experiments upon which the new formula is based were conducted on apparatus consisting of a battery of 6-in. glass tubes, 50 in. long, mounted and clamped between two special brass castings, and sealed with rubber gaskets and cement. The lower casting was funnel-shaped and filled with graded gravel to equalize washwater distribution. The sand layer was separated from the gravel by a perforated brass disk covered with a fine screen, both secured to the top of the lower casting. The screen gave a definite base line from which to measure sand depths, and permitted the removal of the entire sand sample without admixture with gravel. A more complete description of the experimental apparatus appeared in *Engineering News-Record*, July 16, 1931, page 109. The empty tubes were first calibrated for loss of head at different rates of flow, and all subsequent loss-of-head readings taken with sand in the filters were reduced to the basis of sand loss only.

The sand sample to be studied was poured into the filter tube and thoroughly backwashed. The washwater valve was closed very slowly, not only because this seemed to simulate large-scale plant practice, but more for the reason that this procedure was found to be the only way to obtain a fixed and definite sand depth, one which could be duplicated with successive backwashings. In all the experiments only clear filter water was applied to the sand, and consequently no clogging of the bed took place.

The reading of sand depth was taken after the effluent valve was opened, since a slight initial subsidence of the sand bed takes place when any filter is first put in service after washing. In these experiments no further reduction in depth was ever noted. However, any jarring or vibration of the apparatus would have resulted in further compacting of the sand layer, and because of this was studiously avoided.

The rate of flow for any effluent valve setting was obtained by collecting and measuring the discharge for a definite time interval, using a graduated cylinder and stop watch. Having previously calibrated the tubes for cross-sectional area, or diameter, the volume of discharge per minute was readily converted into million gallons per acre daily. Two or more such measurements were made at each set rate, and the temperature of the effluent was read immediately before and after each measurement of discharge. The rate-of-flow measurements were accepted as accurate only when the temperature variation during a succession of different rate settings was not more than 1 deg. F., and when successive volume-discharge readings for the same rate did not vary more than 2 per cent. Loss-of-head readings were taken simultaneously with those of rate of flow to the nearest 0.01 ft.

The loss of head resulting from the passage of water through sand is dependent upon a number of factors, the most obvious of which is the diameter, or size, of the sand grains. In a rapid filter bed the sand is stratified and consists of a number of layers which increase in particle size from top to bottom. As water flows through such a bed each stratum contributes to the total loss of head a value dependent on its particular depth and grain size. To evaluate the loss for any one size, or layer, it must first be separated from those adjoining. This was accomplished for the purposes of this study by sieving out eight separate fractions of clean Ottawa sand, each having the highest possible degree of uniformity of size and differing one from the other only in the grain diameter. Each of these experimental sands, in volume sufficient to fill the experimental tube to a depth of about 30 in., comprised the fraction which was retained between two consecutive sieves.

Size determinations of these eight uniform sands were made by three independent methods, the results of which are shown in Table I. The "count-and-weigh" method is that devised and recommended by the late Allen Hazen, and when applied to these round sand grains undoubtedly gives accurate results. The mean microscopic diameter, as measured with an ocular micrometer,

TABLE I—CHARACTERISTICS OF UNIFORM EXPERIMENTAL SANDS

Sand No.	Sieve Nos.	Mean Diameter in Millimeters: Count and Weigh	Micro-Measure	Median Size	Uniformity Coefficient	Porosity (% Void)
1	By 48 On 65	0.289	0.297	0.287	1.08	38.7
2	By 42 On 48	0.374	0.386	0.361	1.03	37.0
3	By 35 On 42	0.435	0.426	0.420	1.05	36.7
4	By 32 On 35	0.510	0.523	0.503	1.05	37.3
5	By 28 On 32	0.614	0.601	0.600	10.4	35.8
6	By 24 On 28	0.709	0.690	0.700	1.03	35.4
7	By 20 On 24	0.899	0.908	0.831	1.06	35.3
8	By 16 On 20	0.997	.....	1.025	1.05	35.2

TABLE II — CHARACTERISTICS OF GRADED TEST SANDS

Sand No.	Source	Grain Shape	Size in mm.: 10% Finer	60% Finer	Uniformity Coefficient	Porosity (% Void)
9	Ottawa, Ill.	Round	0.324	0.465	1.43	36.1
10	Red Wing, Minn.	Round	0.490	0.698	1.42	33.9
11	Phalanx, Ohio	Sub-Angular	0.621	0.897	1.44	40.4
12	Cape Cod, Mass.	Sub-Angular	0.491	0.663	1.35	38.9
13	Ottawa, Ill.	Round	0.370	0.735	1.99	35.0
14	Cape May, N. J.	Sub-Angular	0.430	0.780	1.81	35.5
15	Phalanx, Ohio	Sub-Angular	0.416	0.600	1.44	39.9
16	Muscatine, Ia.	Sub-Angular	0.595	0.870	1.46	37.0
17	Ottawa, Ill.	Round	0.550	0.830	1.51	34.9
18	Muscatine, Ia.	Sub-Angular	0.600	0.987	1.65	36.0
19	Ottawa, Ill.	Round	0.540	0.868	1.50	34.7
20	Copley, Ohio	Angular	0.540	0.765	1.42	48.4
21	Ottawa, Ill.	Round	0.341	0.544	1.60	34.5
23	Mixture of Nos. 15 and 20	Angular and Sub-Angular	0.440	0.670	1.52	42.9
24	Mixture of Nos. 15 and 20	Angular and Sub-Angular	0.479	0.730	1.52	45.6
25	Mixture of Nos. 15 and 20	Angular and Sub-Angular	0.441	0.660	1.50	41.7

represents the average measured diameter of a large number of grains. The median size is the diameter midway between the openings of the two limiting sieves.

In addition to these eight uniform sands, sixteen other representative graded filter sands of different kinds were studied, all of which fell within the usual filter sand range in respect to size, grain shape and uniformity. The characteristics of these sixteen graded are listed in Table II on p. 647.

Tests on uniform sands

It is obvious that a series of experiments performed on any one of the eight uniform sands will have the factor of sand size constant in all experiments as well as throughout the full depth of the experimental filter bed in any single experiment. The two straight lines in Fig. 1 show the results of experiments conducted with one of these uniform sands. The lower curve, showing the relation between loss of head and depth at a constant rate of flow and water temperature, was obtained by dividing the sand sample into eight equal representative portions and then measuring the loss of head after each successive portion, or depth increment, had been added and the bed rewashed and graded. Together, the curves show that there is a proportional relation between loss of head and depth of bed, and between loss of head and rate of flow. Using the direct proportionally so found, all subsequent loss-of-head measurements in the study were corrected to a depth of 100 in. and a rate of flow of 125,000,000 gal. daily per acre (125 m.g.d. per acre).

Loss-of-head measurements of the uniform sands were made at five different temperatures, between the limits of 35 deg. and 72 deg. F. Readings were taken at five or six different rates for each sand at each water temperature, and the closeness with which the points plotted to a straight line was regarded as an indication of the constancy of the water temperature.

Five loss-of-head measurements for each of these sands, corrected to a depth of 100 in. and a rate of 125 m.g.d. per acre, and the corresponding water temperatures are shown graphically in Fig. 2. The plotted data produced curves of the temperature-viscosity type and are found to be represented by the equation

$$l = \frac{a}{t + k}$$

In this expression k is theoretically a constant, although when its value is calculated for each of these eight sands, small variations occur due to experimental error. The larger the number of sands employed the more accurately can the value of k be determined. Therefore ten of the graded sands were selected and their head losses measured at two different temperatures. By solving simultaneous equations for each of these ten sands, values of k were obtained which when added to those of the eight uniform sands gave a mean value of 20.6. The effect of temperature alone can therefore be expressed as:

$$l = \frac{a}{t + 20.6} \qquad (1)$$

where l is the loss of head in feet and t is the temperature in Fahrenheit degrees.

Using this expression, the values of a can be calculated from the data obtained from each of the eight uniform sands. These values are shown plotted against corresponding sand sizes in Fig. 3. In this diagram the short horizontal lines drawn through each set of points represent the range of size for each sand—that is, the limiting sizes according to the calibrations of the two sieves between which each sand is retained. The three different size values for each sand are plotted on the corresponding horizontal line of limiting sieve sizes. The size values determined by the "count-and-weigh" method give the best straight-line plotting of any of the three sets of values, with the single exception of the point representing the finest sand. When the locus was computed to fit these points, the finest sand was omitted from the calculation because it was obviously being affected by some variable not influencing to the same extent the other seven sands. The disturbing factor was later found to be that of porosity, which will be discussed further in another paragraph. The equation of the curve in Fig. 3 gives the values of a in terms of sand size and can be expressed as:

$$a = \frac{123}{s^{1.89}} \qquad (2)$$

By combining equations (1) and (2)

$$l = \frac{123}{s^{1.89}\,(t + 20.6)} \qquad (3)$$

This expression holds for the conditions under which it has been developed—that is, when the depth of the sand layer is 100 in. and the rate of flow is 125 m.g.d. per acre. Since the loss of head is directly proportional to both of these variables, they can be included in the equation as:

$$l = \frac{9.84}{10^3}\left[\frac{dr}{s^{1.89}\,(t + 20.6)}\right] \qquad (4)$$

where l is the loss of head in feet, d is the depth of sand bed in inches, r is the rate of flow in m.g.d. per acre, s is the sand size in millimeters and t is the water temperature in Fahrenheit degrees.

Application to graded sands

Of course the other special condition under which the formula has been developed is the high degree of uniformity of the sands from which the data were obtained. Naturally the question arises

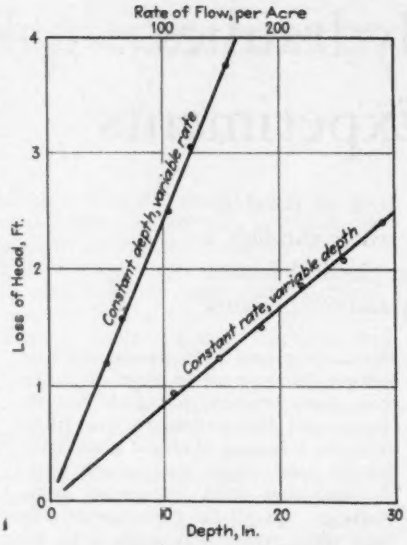


Fig. 1—Under constant conditions of sand characteristics and water temperature the loss of head is directly proportional to depth of bed and rate of filtration.

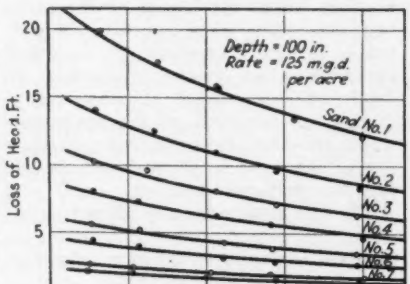


Fig. 2—Loss of head decreases as the water temperature rises, due to the decrease in viscosity.

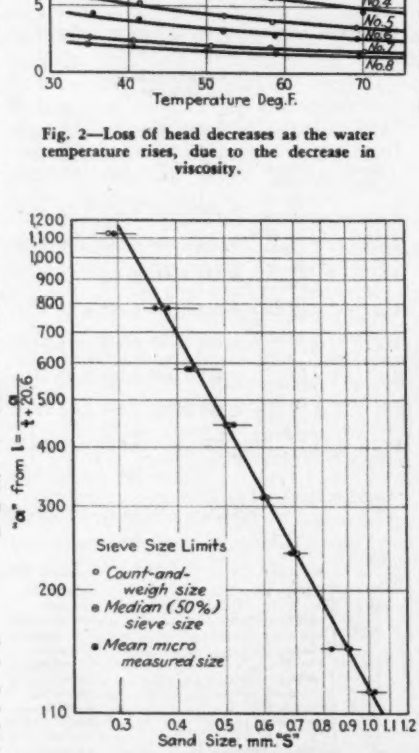


Fig. 3—Under constant conditions of depth, rate and temperature the loss of head through a bed of uniform sand varies inversely as the 1.89th power of the grain diameter.

TABLE III — RELATION OF LOSS OF HEAD TO POROSITY

(For ten graded test sands at 125-m.g.d. per acre rate and 100-in. depth)

Sand No.	Temperature (deg. F.)	Loss of Head, Ft. — Actual	Loss of Head, Ft. — Computed (Formula 4)	Porosity Coefficient	Porosity (% Void)
9.....	36.4	10.43	12.82	0.814	36.1
	60.6	7.58	8.99	0.843	
10.....	35.2	5.00	5.57	0.897	33.9
	60.5	3.34	3.83	0.871	
11.....	35.2	2.39	3.37	0.708	40.4
	60.5	1.74	2.32	0.750	
12.....	35.7	4.25	5.63	0.755	38.9
	60.6	2.94	3.90	0.754	
14.....	38.6	4.58	5.50	0.832	35.5
	60.8	3.27	4.00	0.817	
16.....	35.2	2.96	3.70	0.800	37.0
	60.7	1.99	2.54	0.784	
20.....	36.1	2.36	4.48	0.527	48.4
	60.5	1.62	3.13	0.517	
21.....	35.7	7.81	9.56	0.817	34.5
	61.3	5.76	6.57	0.878	
23.....	45.7	3.48	5.34	0.653	42.9
	60.6	2.91	4.36	0.667	
24.....	45.6	2.58	4.60	0.561	45.6
	61.6	2.12	3.70	0.573	

as to the applicability of the formula to the ordinary graded sands. It has already been pointed out that when a graded sand is subjected to a sieve analysis, any fraction of the sand which is retained between two consecutive sieves must of necessity be of a high degree of uniformity, and is therefore similar in this respect to the uniform sands from which the formula has been derived. For a graded sand, to determine the size of each sieve fraction by the count-and-weigh method would not only be tedious but would also be subject to error with sand grains of irregular shape. Failing this, it is logical to accept the median size between sieves as equally representative of the average size of the fraction retained. An obvious advantage of this is that the median sizes between sieves are a set of constants for any given calibrated screen series.

Assuming a sand bed 100 in. deep and a condition of perfect grading from top to bottom throughout the bed, the percentage figures given by the ordinary sieve separation test represent the depth in inches of each size fraction in the bed of graded sand. On this basis, by calculating the loss of head for each fraction, the total loss of head is obtained by summation for each of the ten graded sands as shown in Table III. The discrepancies between the calculated losses and the measured losses are indicated by a coefficient which is obtained by dividing the actual measured loss by the calculated value. Representing this coefficient by C_p the formula may be rewritten to include it, as follows:

$$l = \frac{9.84\, C_p}{10^3}\left[\frac{dr}{s^{1.89}\,(t + 20.6)}\right] \qquad (5)$$

As this coefficient is found to be far from constant, the actual loss of head must be further influenced by some variable not yet evaluated. The only important factor not yet taken into consideration is the difference in shape exhibited by the sand grains.

Effect of grain shape

A serious attempt was made to find a microscopic parameter of grain shape, but the effort was finally abandoned, as any such method seemed likely to prove tedious and impractical of application. A measure of the effects of grain shape was then sought that would be capable of serving the purpose.

One of the immediate effects of a departure in shape from round to angular is an increase in surface area. A sphere presents the minimum surface area per unit volume of any geometrical solid, therefore as the grain departs from the truly spherical shape its surface area increases. In the filter bed this should apparently result in an increase in loss of head due to the greater frictional area, but the table shows that the measured losses for all these filter sands are less than the calculated values based on the formula derived from round-grain sand. Lower resistance by the irregular-shaped grains is indicated. This can only mean that the pores between the grains of angular sand are larger than the pores between round grains of the same measured size, and a measurement of the porosity of the graded sand should indicate the value of the coefficient required.

Several methods of measuring porosity were tried, and one method was developed which is recommended as being simple and accurate and not requiring special apparatus or technique. The long graduated glass tube from a Jackson turbidimeter is firmly clamped in a vertical position and half filled with water, to give a column about 40 cm. high. A wide-stem funnel is secured above the mouth of the tube, but not in contact with it. A representative 400-gram sample of the sand is carefully weighed and then poured through the funnel into the tube in about ten successive fractions, allowing each to settle to the bottom before the next is poured. In falling through the water column the sand tends to grade itself hydraulically into ten stratified, miniature filter layers. Throughout the pouring operation, extreme care should be exercised not to touch or jar the apparatus in any way to cause a false settlement of the sand. A reading of the total volume of the sand is then made. From the weight and specific gravity of the sample the porosity can be calculated in terms of void percentage. With a tube of internal diameter of about 1 in. and with a specific gravity of silica sand of 2.65, the porosity may be calculated from the equation:

$$\text{porosity} = 100 - \frac{37.7\, w}{v} \qquad (6)$$

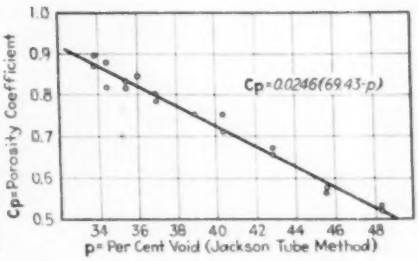


Fig. 4—As the angularity of the grains increases, resulting in increasing porosity, the loss of head becomes smaller.

Fig. 5—Diagram for the graphical solution of the loss-of-head formula. To use this diagram, or to apply the formula, the filter bed is considered to be made up of a series of layers each composed of uniform sand. The thickness of each layer and the diameter of its grains are taken from the sieve analysis. For example, if the sieving of a sample shows that 18 per cent is retained between sieves having openings of 0.746 and 0.930 mm. respectively, the corresponding stratum in the filter has a thickness of 18 per cent of the total depth, and the grain diameter is 0.838 mm.

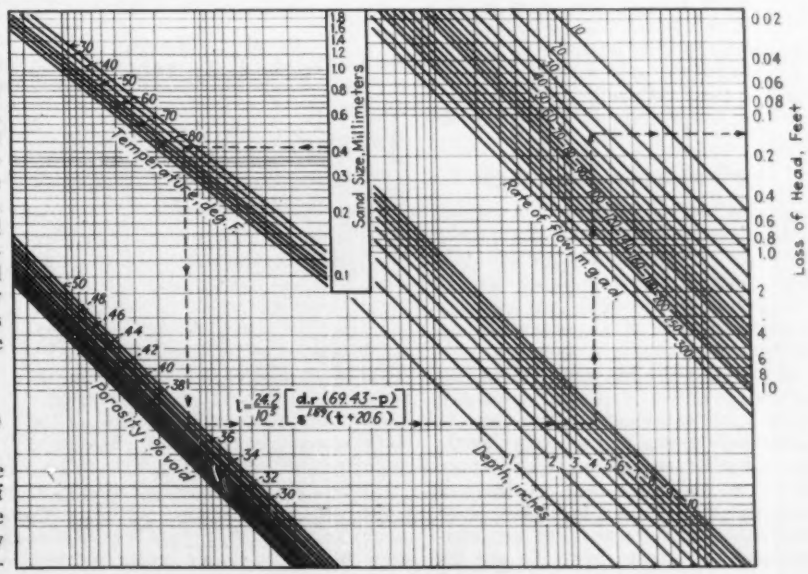

Temperature, deg. F.
Sand Size, Millimeters
Porosity - % void
Rate of flow, m.g.a.d.
Depth, inches
Loss of Head, Feet
l = 24.2/10³ [dr (69.43-p) / s^1.89 (t+20.6)]

TABLE IV — LOSS OF HEAD FOR 16 GRADED TEST SANDS
(Actual loss compared to that computed by Hazen's formula and formula 8)
(For 100-in. depth and 125-m.g.d. per acre rate)

Sand No.	Temperature (Deg. F.)	Loss of Head, Ft. Actual Loss	Computed by Formula 8 Loss	% Error	Computed by Hazen's Formula — When c = 700 Loss	% Error	When c = 1,000 Loss	% Error
9	36.4	10.43	10.36	—0.7	17.14	+ 64.3	12.01	+15.1
	60.6	7.58	7.27	—4.0	11.27	+ 48.7	7.90	+ 4.2
10	35.2	5.00	4.87	—2.6	7.70	+ 54.0	5.39	+ 7.8
	60.5	3.34	3.35	+0.4	4.94	+ 47.9	3.46	+ 3.6
11	35.2	2.39	2.41	+0.7	4.78	+100.0	3.35	+40.2
	60.5	1.74	1.66	—4.8	3.07	+ 86.4	2.15	+23.6
12	35.7	4.25	4.22	—0.8	7.58	+ 45.9	5.31	+24.9
	60.6	2.94	2.93	—0.5	4.91	+ 67.0	3.44	+17.0
13	38.7	5.74	5.86	+2.1	12.52	+118.1	8.77	+52.8
14	38.6	4.58	5.59	+0.2	9.29	+102.8	6.51	+42.1
	60.8	3.27	3.31	+1.2	6.37	94.8	4.46	+36.4
15	38.6	4.96	4.95	—0.3	9.93	+100.2	6.96	+40.3
16	35.2	2.96	2.95	—0.3	5.23	+ 76.7	3.67	+24.0
	60.7	1.99	2.02	+1.6	3.34	+ 67.8	2.34	+17.6
17	35.3	3.32	3.41	+2.9	6.10	+ 83.7	4.27	+28.6
18	40.1	2.68	2.53	—5.5	4.63	+ 72.8	3.24	+21.7
19	35.8	3.50	3.65	+4.5	6.26	+ 78.9	4.39	+25.4
20	36.1	2.36	2.32	—2.0	6.23	+164.0	4.36	+8 .7
	60.5	1.62	1.62	0	4.07	+251.2	2.85	+75.9
21	35.7	7.82	8.15	+4.2	15.75	+101.4	11.04	+41.2
	61.3	5.76	5.60	—2.8	10.10	+ 75.3	7.07	+22.7
23	45.7	3.48	3.49	+0.1	7.77	+123.2	5.44	+56.3
	60.6	2.91	2.85	—2.0	6.13	+110.6	4.29	+47.4
24	45.6	2.58	2.69	+4.4	6.55	+153.9	4.59	+77.9
	61.6	2.12	2.17	+2.4	5.09	+140.0	3.57	+68.4
25	45.6	3.60	3.69	+2.6	7.74	+115.0	5.42	+50.6
Mean Error			± 2.1			+ 87.8		+36.6
Maximum Error			± 5.5			+251.2		+84.7
Minimum Error			0			+ 45.9		+ 3.6

where w is the weight of the sand in grams and v is the volume of sand in cubic centimeters as graded in the tube.

The porosity of the sand as determined by this method is about 85 to 90 per cent of the true porosity as it exists in the filter bed, but the results by the simple test just given are equally applicable. Plotting the porosity by this method against the porosity coefficients, a straight-line function is obtained indicating that

$$C_p = 0.0246\,(69.43 - p) \qquad (7)$$

where C_p is the coefficient of porosity and p is the porosity as determined by the tube method. This value for the coefficient C_p may now be substituted in the basic equation, yielding:

$$l = \frac{24.2}{10^5}\left[\frac{dr\,(69.43 - p)}{s^{1.03}\,(t + 20.6)}\right] \qquad (8)$$

where l is the loss of head in feet, d is the sand depth in inches, r is the rate of flow in m.g.d. per acre, p is the porosity, s is the sand size in millimeters and t is the temperature in Fahrenheit degrees.

Error in application is slight

The results of applying this formula to sixteen graded test sands, six of which have in no way been involved in its derivation, are shown in Table IV. The low average error of 2.1 per cent and a maximum error of 5.5 per cent demonstrate its high degree of accuracy.

A study of the literature of the subject discloses two other similar formulas based upon experimental data: one by Baldwin-Wiseman and the other by the late Allen Hazen. Both are based upon data from the old slow sand filters in which no stratification has taken place, the smaller sand grains filling the interstices of the larger ones. To use the Baldwin-Wiseman formula a determination is required of the thickness of the film of water retained on the grains when the sand is drained, and also the surface area of the grains per unit volume of the sand, measurements which require lengthy procedures, and which are almost indeterminate for a hydraulically graded sand. Allen Hazen's formula specifies the use of the effective size as obtained from the sieve analysis, and requires a coefficient c, the value of which is said to range between 700 and 1,000 and is dependent upon several variables, notably the shape and composition of the sand grains, the compactness of the filter layer, and the uniformity of the sand. Hazen's formula was applied to the sixteen graded test sands used in this study with the results shown in Table IV. The two extremes of Hazen's coefficient were used, in view of the fact that no method of determining its proper value is specified. The wide range of error in these computations of loss of head by Hazen's formula seem to prove conclusively that the hydraulics of the slow sand bed are in no wise comparable to that of the graded, stratified, sand layer of a rapid filter.

The new formula is recognized as being subject to at least one obvious error, that of accepting a constant porosity value throughout the entire depth of the sand bed. This is not strictly true as reference to the last column of Table I shows. The porosities of the seven larger sands do not vary as much as 3 per cent from the mean value of those seven, but the finest sand varies more than 7.5 per cent from that mean. This probably explains why measurements from this sand could not be included in the data giving a formulation of the size variable. Such errors probably exist to a greater degree in sands of irregular shape, but an error introduced into a single computation of one of the several sieve fractions becomes only a small percentage of the whole, which justifies the fractional method recommended for computing loss of head for any filter sand.

Technical Services Cooperate to Cut Building Costs

By W. G. Mansuy,
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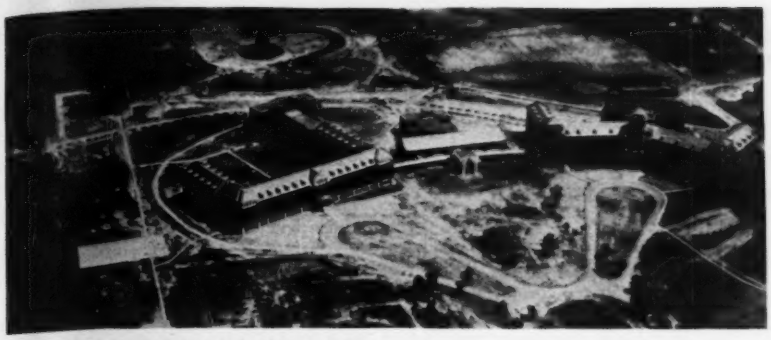
IN THE construction at a cost of $2,500,000 of the extensive group of buildings shown by the accompanying view, an exceptional extension of fixed-fee guaranteed-cost contracts produced a degree of coordination and cost saving that materially advanced progress. This form of contract was extended to the contracting trades—plumbing, heating, electrical work, roofing, sheet-metal work, plastering and painting. The result was a degree of cooperation between owner, architect and contractor which permitted falling prices to be taken advantage of with a saving to the owner of about $250,000.

Cooperation of the technical services began with the planning. Before work on any of the buildings was begun, joint study was given to the proper location and the floor elevations in relation to the finished grade. This point determined, the structural elements were thoroughly analyzed to the end that the best and most economical construction might be used.

It was decided that where changes were required, they should be made before any work was done on the parts affected. This necessitated a bulletin and a drawing, or, when practicable, a bulletin only. These bulletins were sent to all the subcontractors and the job foremen, with orders to proceed with the change, and to check at once with the general contractor for charges and credits because of the change. Although many rearrangements of interiors were made, the credits and debits balanced each other very closely, due principally to the fact that all were made at cost, and, if materials that were fabricated were affected, these materials were



Airplane view of $2,500,000 building project for the St. Mary College and Academy at Monroe, Mich.

properly scheduled and used at other locations.

All contractors were informed that no contra-charges would be made against them, as the general contractor would assume full responsibility for all cleaning, furnishing electric light and power, hoist, heat, replacing broken glass, and that no intolerable conditions would be imposed upon any of the men engaged on the job. Naturally, attractive bids were obtained for the owners, and a cooperation between all the contractors and workmen on the job was brought about that has seldom, if ever, exsisted on any construction project.

In construction one unusual method was used on the floor. It was decided to use an asphalt tile for approximately 25,000 sq.ft. of floor. The old system of a separate cement finish or a troweled monolithic finish as a subfloor for this tile was discarded because it was too expensive and too uneven and wavy. The rough slab was increased about ½ in. and this was screeded off to within ⅛ in. of the finish floor. The slab was ground with terazzo grinders before any building partitions were placed. After the plastering was completed the floors were again given a finish grinding, which left the concrete clean, smooth and ready for the installation of the finish floor.

Construction was started March 25, 1931, and completed Jan. 6, 1932. The architects were D. A. Bohlen & Son, Indianapolis, Ind., and the general contractor was the W. E. Wood Co., Detroit, Mich.

Asphalt Overflow Removed By Luting Brick

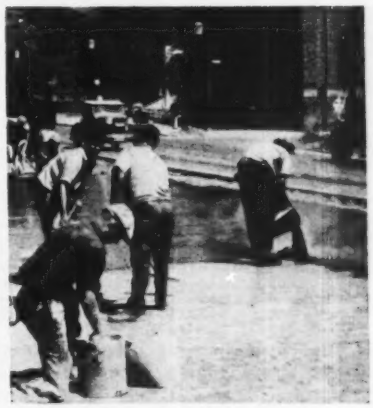
Luting compound resembling paper-hangers' paste enables overflow of joint filler to be peeled cleanly from brick in paving work at Cleveland, Ohio

THE surface-removal method of applying asphaltic joint filler for brick pavement gives increasing evidence, as experience develops, of avoiding the difficulty heretofore encountered in securing complete joint closure without spilling and overflow which obliterate, until after considerable wear, the special characteristics of brick surface. In the past few months the method had been employed on pavements in Pittsburgh, St. Paul, Richmond and Cleveland. The Ohio state highway department has used it with such success that it may be made a requirement in state brick-road practice. Trial of the method is also being made in the brick-resurfacing work being done this year by the Illinois division of roads.

In the paving this year of 20,000 sq.yd. of Pearl Road in Cleveland, Ohio, notably perfect results were secured in removal of the asphalt surface covering. The methods of procedure are indicated by the accompanying views of the work in progress. Briefly, the street, which is 72 ft. wide, with car tracks in the center, permitted unhindered paving operations on one side at a time. The design called for a 3-in. vertical-fiber lug brick on a ¾-in. granulated slag cushion on a 9-in. reinforced-concrete base.

Laying, culling and rolling proceeded in the usual manner, and then the brick surface was brushed with a liquid paste known as B & B adhesion-preventing compound. An advantage of this material is that it is not necessary to wait for it to dry, as is necessary with whitewash, before the asphalt is applied. This was flushed on with no attempt to confine the application to the joints. It was found that very little of the paste entered the joints to reduce the penetration and bond of the filler. As soon as the filler had worked fully into the joints and become stiff, the surplus was peeled off the pavement, leaving the brick surface clean and unblotched. The material that was removed was mixed with an equal amount of new filler material and then remelted and re-used.

Brick luted with a liquid paste applied with brushes in one coat.



Asphalt filler applied by flushing immediately following the luting process.

Overflow of filler peeled from luted surface and used again after reheating.

Why Not Steel Dams?

Review of the pros and cons of metal dam construction in the light of present-day developments in design, fabrication, non-corrosive metallurgy and surface protection

By C. Maxwell Stanley
Young & Stanley, Consulting Engineers, Muscatine, Ia.

WITH the construction of three steel dams in this country more than 20 years ago the use of metal as a dam material has been allowed to lapse. During this interval great strides have been taken by the steel industry, particularly in welding and in alloy discoveries. In consequence every old, partially developed method and material is or should be restudied to determine its present status. Steel is essentially a new material so far as dams are concerned. Enormous bottle-tight sheets may be fabricated through welding. With expansion and contraction properly cared for, there is no limit to the area to be so joined. Steel deserves, as Mr. Stanley points out, a new appraisal at the hands of dam designers if they are to exhaust every possibility of economic design. See also other discussion in *Engineering News-Record*, Oct. 27, 1932, p. 505. —EDITOR.

IS THE engineering profession overlooking something when it ignores the possibilities of fixed steel dams? Steel construction has been successfully applied to many types of gates, shutters and other devices which may be classified as movable dams. We are now going through a period of intense questioning and investigation into theory and practice relative to concrete dams. One has only to look through a bibliography of recent articles to realize how active is the field. But in all of this questioning and investigation we find little comment on the fixed steel dam. Hence the query: Are we overlooking something?

Fixed steel dams in this country date back to the beginning of the twentieth century, when three were constructed. All three of these dams were of the same general design and construction and were constructed by the Wisconsin Bridge and Iron Co. under patents issued to F. H. Bainbridge.

The Ash Fork Dam was constructed in 1898, for the Atchison, Topeka and Santa Fe Ry. near Ash Fork, Ariz., to impound water in a dry canyon. The steel portion of the dam, founded on rock, had a length of 184 ft. and its greatest height was 46 ft. The framing consisted of triangular-shaped bents of steel members spaced 8 ft. on centers on concrete foundations, with a slope of 45 deg. on the upstream face, which was formed of steel plates riveted to the bents. These plates were curved to a radius, thus forming a series of gulleys down the face of the dam. The crest was constructed to function as an overflow weir. This dam was designed by F. H. Bainbridge in collaboration with James Dunn, chief engineer, and the late A. F. Robinson, bridge engineer, Santa Fe System.

The second steel dam was constructed in 1901 for the Atlantic Mining Co. and the Baltic Mining Co. at Redridge, Mich. This structure was also used as an impounding reservoir for water supply. The steel portion of this dam had an overall length of 464 ft. and a maximum height of 74 ft., including the concrete base proportioned to resist overturning and sliding. The general design of the structure was similar to that of the Ash Fork Dam. It was designed by J. F. Jackson, engineer of the Wisconsin Bridge and Iron Works, with F. Foster Crowell acting as consulting engineer.

In 1905 to 1907 the Hauser Lake Dam was constructed across the Missouri River near Helena, Mont., for the Helena Power & Transmission Co. The steel part of the dam was 630 ft. long, 500 ft. of which was spillway, with a maximum height of 81 ft. The general construction was similar to that of the other dams already mentioned, except that to provide a sufficient safety factor against sliding the face was given a 1½ to 1 slope. This dam was constructed on a gravel foundation. One year after completion of construction a break occurred in the dam, resulting from underwashing of the foundation. The dam failed and was replaced with a concrete gravity section. There are no indications that the failure was in any way due to the steel construction.

These installations are the only known ones in the United States. Apparently the steel dam was dropped after the failure of the Hauser Lake Dam, and this type of construction has lain dormant since that time. The Ash Fork and Redridge dams are still in service and according to recent reports are in excellent condition. Maintenance costs are reported to have been at a minimum. This is a record which cannot be equaled by many 20-year old concrete dams.

Steel has also been employed as a waterproof membrane on the upstream face of rockfill dams. One such installation was constructed for the Pikes Peak Power Co. in Colorado in 1901, and according to recent reports has been found satisfactory. A more recent project of this type was completed recently for the Broadmoor Hotel properties near Colorado Springs, Colo. (See *ENR*, May 26, 1932, p. 761.)

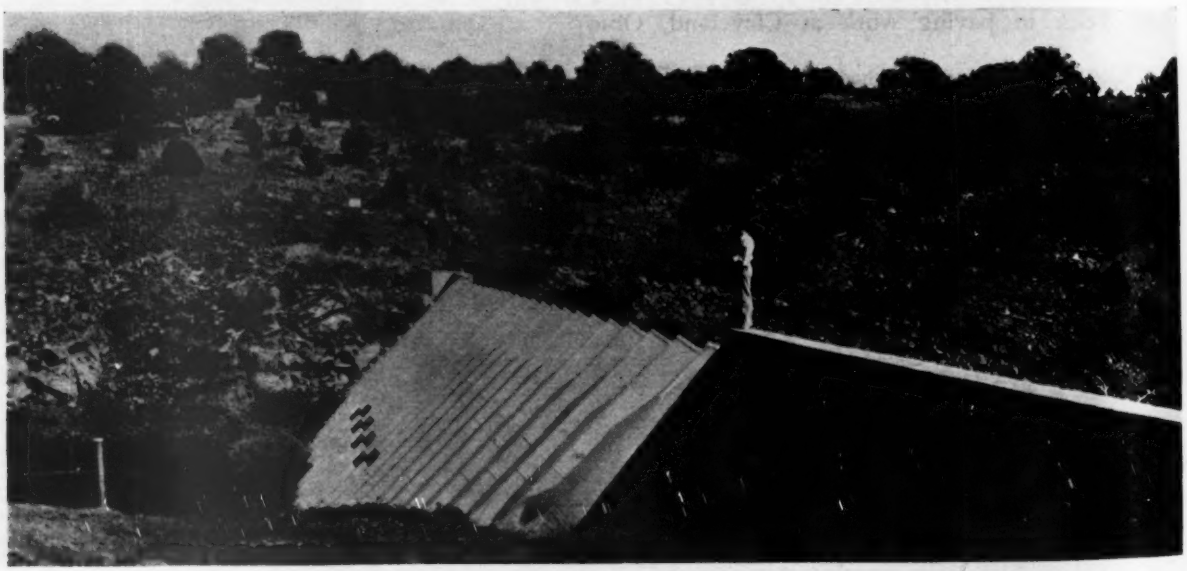


Fig. 1—Steel dam near Ash Fork, Ariz., built in 1898 and still in good condition.

Several types of design may be applied to the construction of steel dams. Four of these which are worthy of consideration are illustrated in Fig. 2: deck, multiple suspension, arch and multiple arch. All of these, and indeed any type of steel dam, consist essentially of three parts: (1) A watertight skin plate supported upon (2) some form of framed structure which transmits the water load from the plate to (3) a suitable foundation.

No attempt will be made here to describe further the details of design. The sketches illustrate in a general way some arrangements which may prove satisfactory.

In addition to the types of steel dam construction suggested above there are numerous designs which might be worked out employing a combination of steel with other materials. One combination already mentioned is the use of a steel membrane on the face of a rockfill dam.

Advantages of steel dams

In further considering the competitive position of the steel dam, the following points are of note: material, design, efficiency, safety, watertightness, construction, permanance and cost.

Steel is a standardized product manufactured in a shop under control. It permits inspection and testing prior to erection, and a uniform product can be obtained.

The design is more determinate than that for almost any other material, as a steel dam would be made up principally of framed structures which may be readily analyzed and designed by existing methods. Handling temperature stresses would be simple, and no such shrinkage stresses as are present in massive structures would be present.

From the standpoint of uplift on the base of a dam a steel structure is in the same classification as a hollow dam and has a decided advantage over a gravity dam. Uplift is not an important factor in arch dams, but even here the steel dam has an advantage.

In general a steel dam uses the material more efficiently than is possible in massive structures, in that the material is used to carry stress rather than to provide weight. In the four types of steel dams outlined in a preceding paragraph, none of the material is used as mass to establish the stability of the structure.

The steel dam, depending as it does upon the weight of water to provide stability, may be readily and economically altered to increase the factors of safety against overturning and against sliding. While this may be done in a similar manner with hollow-type concrete dams, it cannot be done with a gravity-type dam without materially adding to the quantities involved. In arch dams there will be little difference between steel and concrete or masonry dams on this score.

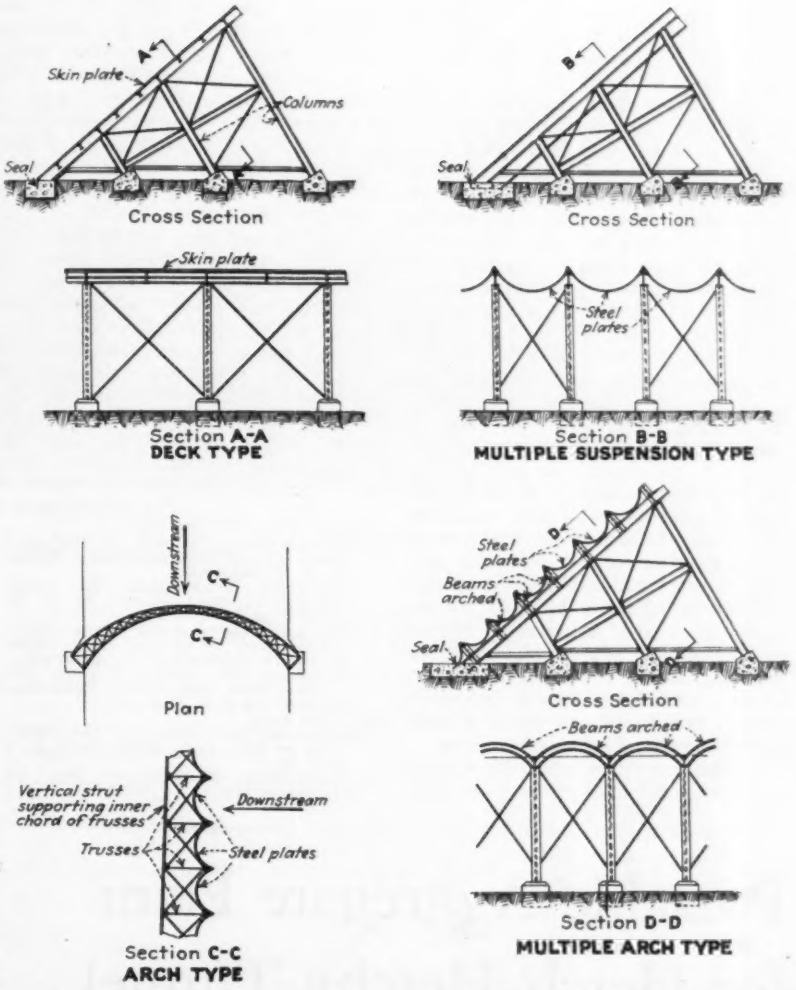


Fig. 2—Designs for four types of steel dam in all of which a skin plate is supported on a framed structure transmitting the load to the foundation.

With available methods of welding and calking, the joints of the skin plate may be made 100 per cent watertight. Steel is an impervious material and with the joints made tight there can be no leakage. Watertightness should be one of the strong points in favor of the steel dam.

The comparison of construction features is principally concerned with speed of construction. The importance of speed is becoming more and more apparent, for a decrease in the time required means a decrease in cost due to lesser interest and overhead charges. The fabrication of a steel dam is a shop process and may easily be speeded up sufficiently so that the supply of material to the field will be ahead of any erection schedule. This decreased time of construction for a steel dam has another advantage in that it lessens the hazards of river work, as the dam may more rapidly be brought above dangerous flood stages.

The question of the permanence of steel dams has in all probability been one of the principal objections to the adoption of such construction. While it is a problem that must be studied thoroughly and carefully handled, it is not one that is incapable of solution nor one which need materially retard the use of steel.

Developments of the last decade or two in the field of metallurgy of steel have resulted in alloys which while not non-corrosive are at least resistant. Future progress in this field may develop steels that are practically non-corrosive. With such a steel all questions of lack of permanence will disappear. However, we do not have such a steel at our disposal today and the question of permanence must be considered from the viewpoint of existing materials.

Steel has been successfully used for many purposes where conditions are as severe as are encountered in steel dams. Gates on locks and dams, pipe lines, water tanks, steel sheetpiling and ship hulls are only a few of the many instances where steel has successfully withstood extreme conditions of exposure. It may be argued that in these applications the steel is protected by paint or other coating which is renewed from time to time and that this main-

tenance is responsible for the long life of steel. If this is so, it is also true that the life of a steel dam may be lengthened by paint or other coating.

The portion of the dam that is always under water consists of the upstream face and occasionally part of the downstream face. These sections are those that permit the undisturbed formation of a protective layer of rust if corrosion occurs, and they are also the surfaces upon which an initial protective coating of paint or other material will remain undisturbed. They will in many cases be protected by a film of silt or mud deposited from the water. These various factors create conditions such that the protection of these areas should not be difficult. Nor should the areas always exposed to air present a problem, for they may readily be protected by painting in accordance with usual practices of maintenance of steel structures. This leaves the section that is alternately exposed and submerged, depending upon water levels. Maintenance here is more difficult, as the action of water, ice and waves will tend to injure any protective coating of paint or rust. However, the mere fact that at times this area is exposed is sufficient to indicate that maintenance may be carried out in a satisfactory manner if attention is given.

Further proof that maintenance is not excessive and that steel dams are relatively permanent is available in the records of the Ash Fork and Redridge dams. Recent reports on these structures indicate that maintenance has been limited to painting once every four or five years and to very minor repairs of a local nature. Bearing in mind that these structures are now 30 years old, one can scarcely say that steel dams cannot be relied upon.

The cost of a steel dam is dependent upon the type adopted and upon the local conditions under which it is constructed. While there is danger in making general statements as to cost, there are indications that in many instances the steel dam is materially cheaper than an equivalent concrete structure. Recent investigations and estimates by the writer for a non-overflow multiple-suspension-type steel dam on rock foundation, and for an equivalent concrete gravity section designed for 50 per cent uplift, give the following comparison:

Height	Cost of Steel Dam in Per cent of Gravity Concrete Dam
20 ft.	100
30 ft.	78
40 ft.	71
50 ft.	66
60 ft.	62

The saving over a hollow-type concrete dam would not be as large. Additional investigations by the writer into the comparative costs of other types of steel dams substantiate the statement that steel construction in many instances will allow material savings in cost as contrasted with equivalent concrete construction.

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Portable Aggregate Plant for Hetch Hetchy Tunnel

Requirement for a million yards of aggregate produced at three or more points along 28½ miles of tunnel met by three-unit design permitting movement by trailers or flat cars

By H. V. Eastling,

Chief Engineer, Pacific Division, Link-Belt Co., San Francisco, Calif.

THE HETCH HETCHY water-supply project for San Francisco, Calif., when completed will supply 400,000,000 gal. of water daily for a future metropolitan population of 5,000,000 and will develop 250,000 hydroelectric horsepower for general use. Water from the melting snows of the Sierra Nevadas will flow by gravity through an aqueduct to San Francisco, without pumping and without exposure to contamination. The work is now complete, with the exception of the Coast Range tunnel. This tunnel, the longest in the world, is 25.2 miles long and extends from Tesla Portal in the San Joaquin Valley, seven miles south of Tracy, Calif., to Irving Portal, near the town of Irvington on the San Francisco Bay side of the Coast Range.

About 1,000 workmen are now employed in constructing the tunnel, and 21 miles has already been driven. Five shafts, two of them over 800 ft. deep, were sunk to facilitate the work and tunneling is carried on from twelve working faces. The tunnel is circular, 10½ ft. in diameter, and is concrete lined its entire length. Over 1,000,000 cu.yd. of aggregate will be required for the complete lining.

Portable plant specified

Careful analysis of the conditions, location, and amount of material involved led to the decision by the city to produce its own aggregate on sites near the tunnel. In May, 1930, bids were received for a portable plant capable of producing 100 tons per hour. The plant was required to be portable because of the necessity of producing the aggregate at three or more points along the tunnel. The Link-Belt Company was awarded the contract to design and build this plant. The plant designed, in addition to other things, provided for absolute portability—it could be dismantled and the largest pieces placed on trailers or flat cars and still be within highway or railroad clearances. The completed plant shown in the accompanying view and drawing started production in the fall of 1930 at Alameda Creek. It is made up of three main units interconnected by belt conveyors, each unit being carried on car wheels operating on a 7½-ft. gage track of 90-lb. rails.

Receiving unit

Unit I, shown in Fig. 1, consists of a 20-cu.yd. steel hopper carried in a structural steel frame, mounted on six 24-in. car wheels. The wheels of each end-truck are single flanged and those of the center truck are flangeless to permit the unit to pass around a long-radius curve if necessary. Wheel brakes and track clamps hold the unit wherever placed.

The hopper was originally equipped with a grizzly made from 40-lb. rails, set for 12-in. space, and arranged to bypass the oversize stone to one side of the hopper when receiving it from dump cars as originally planned. The present method of loading the hopper

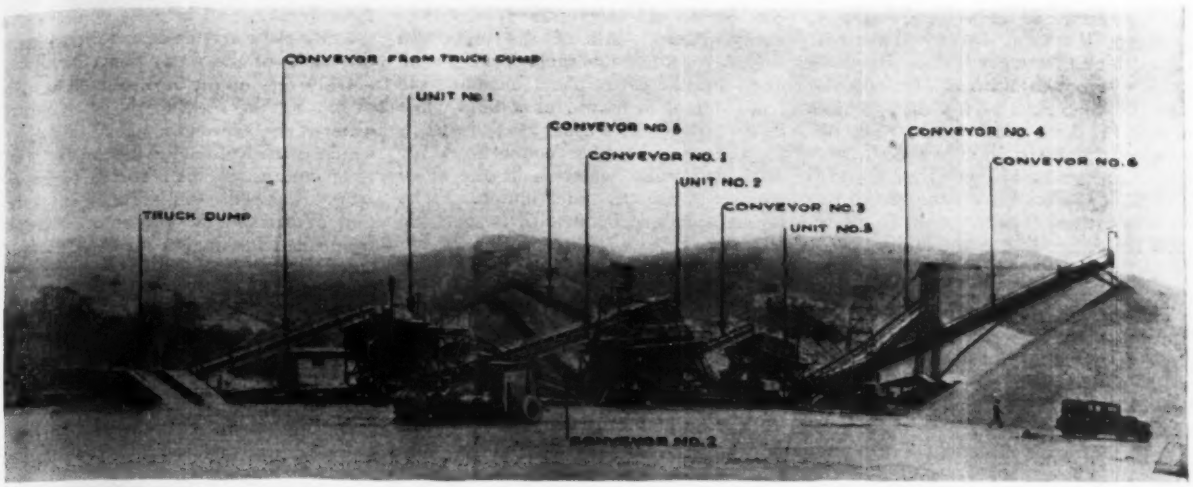

Fig. 1—Portable aggregate plant as set up on line of Coast Range tunnel of Hetch Hetchy water supply for San Francisco, Calif.

from trucks by an inclined belt conveyor from the truck dump has proved to be the best suited to the sites thus far worked and the grizzly has been removed to the hopper at the truck dump.

A 30-in. reciprocating feeder powered by a 5-hp. motor through a herringbone speed reducer and a chain drive feeds the 30-in. inclined belt conveyor 1 carrying gravel to unit 2. This feeder is fitted with an adjustable eccentric and an automatic weighted gate to compensate for the natural differences found in the various pits and those due to wet and dry seasons. The total weight of this unit is 36,000 lb.

Screening and crushing unit

Unit 2, Fig. 1, consists of a 48-in.x 18-ft. heavy-duty revolving screen, a 36-in. cone crusher, and a 14x38-in. jaw crusher. The screen is powered by a 20-hp. motor through a herringbone speed reducer and a roller chain drive. Both the jaw and cone crushers are driven from 50-hp. motors through belt drives.

All material under 1½ in. is screened to belt conveyor 3 and carried to the washing unit. Materials over 1½ in. and under 4 in. are passed to the cone crusher and the rejects to the jaw crusher. The product of both crushers is delivered to belt conveyor 2 and carried back to belt conveyor 1. The complete unit, including chutes, etc., weighs approximately 104,000 lb. and is carried on eight single-flanged car wheels. It is also fitted with wheel brakes and track clamps.

Belt conveyor 1, shown on the flow sheet Fig. 2 and in Fig. 1, connects units 1 and 2 and is carried partly on a steel truss flexibly supported and partly on a rigid frame on unit 2. It is a 30-in. belt carried on troughing idlers at 200 ft. a minute and is powered by a 10-hp. motor through a speed reducer and roller chain drive, all located on unit 2.

Belt conveyor 2, carrying the product of both crushers, is supported by a steel truss flexibly connected to units 1 and 2. It is 18 in. wide, carried on troughing idlers at a speed of 250 ft. per minute, and is powered by a 5-hp. motor. The entire drive unit is located on No. 1 unit. A hinged chute delivers the discharge to belt conveyor 1.

Washing and screening unit

This unit is made up of a washing screen, 48 in.x16 ft., with a shell of ¾-in. diameter perforations and a sand jacket with ¼-in. spaces. A 36-in. double sand rake washer is located below the screen. The screen is powered by a 20-hp. motor. The rake washer is driven from a 5-hp. motor. A centrifugal pump supplied by the city and mounted on unit 3 furnishes the wash water.

Material 1½ in. and under is received from unit 2 via belt conveyor 3 and is thoroughly washed in the screen. All material 1½ to ¾ in. is rejected to belt conveyor 4 serving the rock pile. Sizes ¾ to ¼ in. are delivered to belt conveyor 6 serving the pea-gravel pile. Sand ¼ in. and under passes through the double rake for washing and dewatering and is delivered by belt conveyor 5 to the sand pile. The equipment is all mounted on a steel frame carried on four 24-in. single-flange car wheels and is also fitted with wheel brakes and track clamps. The total weight of this unit is approximately 52,000 lb.

Belt conveyor 3 connects units 2 and 3 and is partly carried on a steel truss flexibly supported between the units and partly on a rigid frame on unit 2. It is 24 in. wide, inclined, and carried on idlers at 250 ft. per minute. This belt is powered by a 10-hp. motor. The entire driving unit is located on unit 3. Belt conveyors 4, 5 and 6 serve the rock, sand and pea-gravel piles. Each is an 18-in. inclined belt approximately 100 ft. on centers, running at 250 ft. per minute. They are carried on steel trusses jointed at the center, providing for raising the upper end and to facilitate moving and erecting. The outer end is supported by cables from a 40-ft. steel mast which is carried on a two-wheel truck, and the lower end rests in a pivoted bolster on unit 3. Chain blocks and winches provide an easy means for raising and lowering the conveyors.

These conveyors are clearly shown in Fig. 1. Each is powered by a 7½-hp. motor. The entire drive units are located at the foot end of the conveyors. The novel arrangement of these conveyors

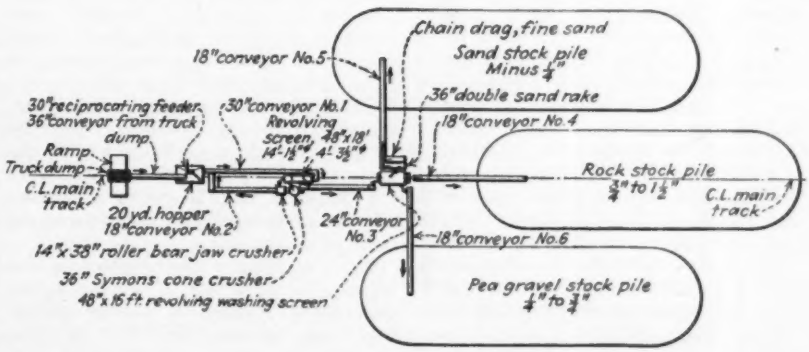

Fig. 2—Flow sheet showing movement of material through portable aggregate plant for Coast Range tunnel for Hetch Hetchy water supply.

is shown on the flow sheet and in Fig. 1. Conveyor 4 extends directly to the rear of unit 3 on the center line of the plant, and conveyors 5 and 6 are on opposite sides of this unit. This arrangement results in three stock piles, each approximately 35 ft. high, on 47-ft. centers. The masts of conveyors 5 and 6 have their truck wheels arranged to run on single tracks, each set 46 ft. 2¼ in. from the center line of the main plant.

General facts

The main wiring controls of the entire plant are concentrated at unit 2. Push buttons are located at strategic points and control the entire plant or individual units. All wiring on each unit is in rigid conduit with the exception of the flexible conduits fitted with connecting boxes so arranged that the plant may be dismantled for moving. The plant, weighing over 175 tons, is easily moved. All of the units are linked together by cable bridles and guys, and the entire plant, including the truck dump, is moved as a unit while in operation. The usual move is 16 ft. at a time. Flexible connections for wash and waste water make the move possible without interruption. The layout is unique because of its portable features.

This plant has carried its rated capacity for 23½ hours per day, weather permitting, and in some cases where pit conditions have been favorable, this output has been easily exceeded.

Aggregate has been produced at Alameda Creek, Corral Hollow and Vallé, totaling more than 900,000 tons to date, successfully demonstrating the practicability of a portable plant of this type and size.

Letters to the Editor

Waterworks Are Self-Supporting

Sir—The statements made in the letter by Mr. Lewis E. Ayres in your issue of Oct. 27 are in agreement with the opinion of the writer formed after long association with municipal utilities in this section. The charge that many publicly owned waterworks are partly subsidized by the municipality is undoubtedly true in some instances, but the writer believes that the reverse is true as a general rule: the waterworks systems are utilized to bring profit to the owners in the forms of cheap water, free fire-protection service, (or service at less than cost) and often by actual cash donations to the city, in addition to the payments of their own costs. Needless to say such profit frequently does not result from equitable charges to the consumer.

The writer believes that the possibility for such generosity is due partly to the well-known facts of freedom from taxation, low management costs, if any at all are charged, free office space in the city hall or some other public building, and often help that is paid entirely or in part by other city departments. In addition to the above, the capital assets often are built up by extensions and improvements financed out of earnings. Furthermore, many states require that bonds, when issued to pay for capital improvements be retired within a definite period of 20 to 30 years, while the structures for which they were issued to pay have useful lives of 40 to 100 years or more. Many municipal waterworks therefore at the end of the bond-retirement period possess property with only partial impairment of the original value, and with no debt or interest charges to pay. Obviously under these conditions the ordinary rate schedule should bring in more revenue than is required to pay the legitimate expenses.

It is needless to say that the policies that bring these conditions about do not always promote equity or fairness to the consumer. If the system has been paid for in the past, then the present profit is a result of the penalties imposed on the past consumers. If sufficient revenues are not set aside in reserves to pay the proper fixed charges, then the present consumers are apt to be benefiting at the expense of the future rate payer or taxpayer. But if the revenues are more than is necessary for the proper charges, or if large reserves are built up, then too frequently the opportunity is seized for dishonest or political tampering with the affairs of the department. Despite all these things both the taxpayer and the consumer generally derive benefits far in excess of the costs of them.

For example: a hasty survey of the policies under which 21 of the larger waterworks systems in Kansas operate was made recently. Nineteen of them are publicly owned. Of these nineteen only twelve make any charge at all for fire-protection service, and four of the twelve will discontinue the charge this year in order to lower taxes. The maximum charge made for this purpose by any of the twelve amounts to $1.01, the minimum 40c. and the average 67.33c. per capita per year, as compared with the $2 to $3 per capita usually considered to be the cost of the service. The two cities with privately owned systems pay $1.37 and 48c. respectively.

Of the 19 cities with public ownership, the seven with no fire-protection service charge, and four others that do make a charge donate all of the water for city use, one in fact furnishing free water to fifteen churches and two cemeteries. It is believed that all of the nineteen cities furnish free office quarters in the city hall, and in most of them also the city clerk acts as collector and keeps the books of the water department.

Only one of the nineteen cities fails to pay all the waterworks costs out of waterworks revenue; but this city, which recently found it necessary to develop an entirely new source of supply at great expense on account of pollution of the old by salt-water drainage from oil fields, makes no charge either for fire-protection service or for water used by the city.

Three of the cities receive substantial donations in cash from the water department. Last year amounts of $10,000, $20,000 and $60,000 (the last amount from the water and light department combined) were paid in three cities respectively, all of them of less than 14,000 population.

The rates charged for water in these 21 cities are not high as compared with the usual rates, in fact many of them are very low.

While the writer believes that most waterworks systems are already on a self-liquidating basis, or can be made so with no hardship to either the taxpayer or the ratepayer, it would be a boon to municipal ownership if all were required to institute honest and adequate accounting practices. No doubt those cities which will borrow from the R.F.C. will receive a great deal more benefit from it than simply the borrowing of the money.

CHARLES A. HASKINS,
Consulting Engineer.

Kansas City, Mo.,
Nov. 2, 1932

Fire Test of Steel-Joist Floors

Sir—In view of the interest in light and economical fire-resistive construction, and because of the numerous inquiries relative to the degree of fire resistance of steel-joist floors, I am calling to your attention the test recently made at Columbia University upon a long-span design and described in a report by Prof. A. H. Beyer.

The panel tested was 14x20 ft., supported by twelve standard steel joists made by four different manufacturers. The ceiling was of metal lath and gypsum plaster ¾ in. thick with a key from ½ to ¾ in. The top slab was a 2-in. concrete slab with a 1-in. concrete finish on one-half of the area and a wood finish attached to wood sleepers set in the concrete on the other half. There was 1½ in. of concrete under the sleepers. The designed live load was 75 lb. per sq.ft., and the dead load 49 lb. per sq.ft.

The fire was a standard fire according to the A.S.T.M. tentative standard and continued for 2 hr., 35 min., at which time a hose stream was applied and the fire extinguished. During the test a load of pig iron equal to 75 lb. per sq.ft. (the designed live load) was in place on the slab. Following the fire test, the load was increased to 150 lb. per sq.ft.

as required in the A.S.T.M. standards, which load was supported until removed the following day.

At the end of 2½ hours the average temperature on top of the concrete portion of the floor (taken beneath an asbestos pad) was 229 deg. F., or 160 deg. F. over the original temperature, and the temperature over the wood floor was 188 deg., or 120 deg. over the original temperature. The A.S.T.M. standards specify that this temperature rise shall not exceed 250 deg., so that the actual rise was well within the required limits.

The floor successfully resisted the standard 2½-hr. fire, and at the end of 2 hr. the wood sleepers and top floor were undamaged. At the end of 2½ hr. the wood top floor commenced to burn.

According to tests made at the Bureau of Standards 20 lb. of wood or other combustibles is required for each square foot of floor area to sustain a fire equivalent in destructive action to a standard 2-hr. fire, and 25 lb. for a 2½-hr. fire. Inasmuch as such light occupancies as apartments, hotels, offices, schools, churches, hospitals, etc., do not contain more than 5 to 10 lb. of combustibles per square foot, it is evident that a steel-joist floor protected with a metal lath and plaster ceiling is entirely adequate to resist a complete burn-out of the contents of such occupancies.

In the recommended minimum requirements for fire-resistance construction published by the building code committee of the U. S. Department of Commerce, two types of fire-resistive construction are recognized, one to resist a 1½-hr. standard fire and the other a 2½-hr. fire. The above floor appears to meet the requirements of the 2½-hr. fire.

In the more recent building codes somewhat similar provisions are being introduced. For instance, the new proposed New York code requires floors having a 1½-hr. resistance for semi-fireproof construction, which is to be permitted in the construction of apartment houses up to nine stories.

For many years it has been customary to require in theory floors having a 4-hr. fire resistance, but in practice many types of construction have been permitted that have never been tested at all and, that would certainly not resist such a fire. It is not good engineering to specify more than is needed, and it is still worse to accept the unknown and untested by the simple expedient of believing that an untested construction may be satisfactory. Good practice dictates that we should specify only what is needed with a moderate margin for safety, and then by actual tests determine that the construction used provides the necessary properties.

It is a distinct advance in the building arts to reach a point where it is possible to design fire resistance to meet the actual needs of the structure just as we have for years designed floor-carrying capacities to suit the demands of various occupancies. The test which Professor Beyer has made with so much care is an important addition to our rather meager knowledge on this important subject.

FRANK BURTON,
Steel Joist Institute.

Detroit, Mich.,
Oct. 28, 1932.

Steel Joints in Rockfill Dams

Sir—I am interested in reading the letters by M. N. Baker and James B. Girand in your issue of Oct. 27, 1932. Mr. Baker's reminiscences on the fate of all steel dams interest me and show about 50 per cent failures in all steel dams.

The object of my letter of July 28 was not to indict steel dams but to show the undesirability of using steel for joints in the concrete facing of rockfill dams.

The history of the joints in Morena Dam, Bowman Dam and Dix River Dam is convincing, and vertical joints 48 ft. apart provided absolute safety in the final readjustment of the structure. To provide absolute safety, it is necessary to have a circumferential joint parallel with the bedrock on the sides of the dam, 10 or 12 ft. therefrom.

I have been keeping close touch with all the rockfill dams, on one of which I was constructing as well as consulting engineer, and on the two others I was engaged as consultant and can testify to the safety of the jointing system without steel. There is no such condition existing either in the Morena Dam or the Dix River Dam as "excessive settlement on the steep face to cause distortion and rupture"; and the Morena rockfill dam survived in San Diego County in the enormous floods of 1916, when dams and bridges of every kind were wrecked in San Diego County.

The oldest hydraulic structures we have in the world are the aqueducts of ancient Rome, described so well by Mr. Herschel in his translation of a book on the water supply of Rome by Sextus Julius Frontinus. The old Romans did not have the art of making cement by such high standards as we have developed today; but as a tribute to their skill and honesty those structures built 2,000 years ago are still in existence. The law, strictly enforced in Rome of those days, was that if lime was too freshly used the contractor was put in jail. Hence the Romans observed the law and good sane methods of construction.

M. M. O'SHAUGHNESSY,
San Francisco, Calif., Consulting Engineer.
Nov. 4, 1932.

National Public-Works Policy

Sir—The nation, it appears, has turned to the construction industry as the most promising road to a revival of general trade. It also appears that our last hope is in the success of the Reconstruction Finance Corp. Everything depends upon the success or failure of this venture. But to what use are the funds available through the R.F.C. to be put? It would seem that a program of extensive public works would be most likely to offer immediate employment to a large number of unemployed. There arises, however, the question of how long we can go on with public construction, the need of which in many cases was not felt until very recently. And how permanent a relief will such construction be? Another question, which, it seems to me, is paramount at this time is this: Is it wise to go on expanding our public works when it is more than likely that if we establish a planned national economy many of our American cities will be very materially altered, if not almost entirely abandoned?

We deplore the lack of a planned national economy, which would obviate reckless production and its consequent period of depression, and the headlong rush into a building campaign in many cities which will unquestionably have very little use for their improvements if the nation's industries are put on an efficient operating basis, in accordance with a planned national economy.

Would it not be well to decide, now and definitely, what course we are going to pursue? If we are going to have a planned national economy, should we not inaugurate it without further delay, so that there will be a minimum of waste due to the creation of extensive public works in cities that will have little or no use for them after their industries have been moved to more advantageous locations, where they will produce more economically the goods that are now produced uneconomically and with consequent great waste?

The day of the engineer is just dawning. Is his work going to be slowed by the extra task of uprooting misplaced public works? Or are we going to let him plan now, so that he will not be hampered in the future by the work of clearing away structures and works for which there would be no lasting need? Let us decide now—and plan.

ALBERT M. LOHMAN.

New Haven, Conn.
Oct. 12, 1932.

Low-Heat Cement—Correction

The Bureau of Reclamation brings to notice two errors in the article "Hoover Dam Cement Specifications Tentatively Formulated" (*ENR*, Nov. 10, 1932, p. 558). On p. 559, col. 3, next to last paragraph, in place of "tricalcium silicate ($3CaO.Al_2O_3$)" read "tricalcium silicate ($3CaO.SiO_2$)." On p. 560, col. 3, next to last paragraph, in place of "and a calorimeter, both maintained at constant temperature," read "and a calorimeter bath maintained at constant temperature." Special attention is directed to the latter error as the sense of the passage concerned is completely altered.

Engineering News-Record

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The Wanderer's Plight

FROM the standpoint of work and relief, the army of roving unemployed laborers offers a serious problem with the coming of winter. The nucleus of this homeless band of wanderers is that class of labor which serves construction during normal times, moving from job to job and seldom deriving more than a precarious existence from its work. Today the construction laborer is in a desperate condition, especially as his ranks have been augmented by homeless workers from every other trade. Wherever he goes he finds that relief work is organized primarily for local residents alone. At best he receives a bowl of soup, a flop and orders to move on. With every community straining to take care of its own, relief for the homeless becomes a national problem. More attention must be given to the plight of the homeless laborer in our plans for relief and work. Today he is truly the forgotten man.

Turning the Tables

WHEN times were good and prices were on the uptrend, public utilities sought to have their properties valued for ratemaking purposes on the basis of the cost of reproducing the property at current prices of material and labor. In so doing they took over the "reproduction new" theory of valuation developed by those who in an earlier period of declining prices sought to deflate utility values by scaling down all their historical cost figures to the depressed prices of the time. The utilities acted unwisely when they adopted this theory, for in depression it is too destructive of prudently invested capital, while in times of high prices it brings unjustified return. The effect will soon be all too apparent, for St. Paul has initiated a revaluation of the properties of the utilities serving that city, and this action is but the opening gun of a campaign that promises to sweep the country. Having put themselves on record as favoring the reproduction new theory, the utilities will now find it difficult to keep millions of invested capital from being wiped off their books.

Grade-Crossing Elimination de Luxe

DEDICATION of the new high-level viaduct from Jersey City to Newark signalizes completion of what unquestionably is the ranking highway structure of America. Figures of costs and tonnages of steel and concrete alone would give this new elevated road the leading position, but it has even stronger claim because it is a magnificent embodiment of the growing problem of bypass and distributing highways near centers of population. Specifically, the new road is the outstanding example in America of the vertical bypass highway. The normal manner of bypassing by a horizontal detour around other traffic was impracticable; the road had to be lifted above or depressed below the level of other traffic. For 13 miles its 50-ft. roadway, mostly on viaduct and in subway, passes through occupied land and city streets, crosses railways and waterways. In such an undertaking design of structure was obviously outstanding, but adjustment and improvement of existing main roads to serve as traffic distributors called for planning of even greater complexity. Virtually the whole state highway system felt the effect of the new road on future planning. The completed enterprise therefore is not only an expression of difficult individual design but—as does in some measure every bypass road—represents an influential factor in highway-system development.

Force of Habit

FROM the record of steel-dam construction given on another page it will be seen that all structures of this type were built within a short period of time, that thereafter practice neglected the steel dam and returned wholly to concrete, masonry and earth construction, and that several steel dams have been in continuous service and have performed in completely satisfactory manner. Such a state of affairs, sometimes found also in other engineering fields, suggests that habit has more influence on engineering method than is altogether reasonable. The service record of steel dams is proportionately as good as that of other types, if account is taken of the fact that the Hauser Lake Dam was destroyed by causes outside the structure—causes that would have been just as fatal to a solid or hollow dam built of another material. The neglect of steel dams after that failure therefore suggests a tendency to follow precedent. Precedent is entitled to much respect, even more than it often receives; but when blind following of precedent replaces the thoughtful use of experience the result is not altogether satisfying and efficient. On the showing of fact the steel dam has a definite claim to consideration within the range of sites and conditions to which it is adapted, and in neglecting it during a quarter-century engineers may have overlooked a legitimate opportunity for economy.

Reduced Cross-River Traffic

INTERESTING figures showing the effect of the business depression upon toll roads are given in reports upon the traffic over the two Hudson River crossings at New York, the George Washington Bridge and the Holland Tunnel. Traffic through the Holland Tunnel for its fifth year fell off 8 per cent from last year's figure of 12,680,000 vehicles, and about 15 per cent from what would have been expected had traffic increased normally. Traffic over the George Washington Bridge was about 35 per cent below the estimated total for the first year. Despite the decline in traffic, both structures have shown substantial earnings. A net of $2,600,000 for the tunnel is reported, and figures for the first nine months of 1932 show that the bridge has earned a net income of more than one million dollars after payment of operating charges and one million of interest on the funded debt. These figures, however, should serve to emphasize the need for conservatism in the use of estimated traffic figures in studies for bridges and tunnels. Traffic trends usually are assumed to have a uniform upward slope. That a business depression can send the curve downward sharply is now very appar-

ent. The curve of money requirement for a toll structure should not, therefore, be so close to the estimated traffic curve as to make it possible for a business depression to drop income below the outlay necessary to keep the structure solvent.

Plant Planning

DIVISIBILITY of construction plant receives new expression in the operations at the Hetch Hetchy tunnel, as described in this issue, and in the recently completed concreting plant for the Madden Dam, to be covered next week. In the California work separation of plant parts was based on the requirement that the aggregate plant must be set up at three locations along the 21-mile tunnel. At the great dam for the Panama Canal the division was planned solely for purposes of salvage and re-use. The parts were so designed that any unit removed from the others would be by itself a complete producing plant. Thus, the mixing plant is designed for re-use as a commercial central mixing plant. Similarly, the gravel-washing and servicing plant can be installed at any other producing pit. With different purposes in mind the Hetch Hetchy and Madden plants have the common design thought of planned divisibility. This is not a novel thought to constructors, but they have rarely carried it to the finality of purposeful planning. From the examples mentioned such planning appears entirely practicable; it may often be a valuable economy measure.

Filter Bed Hydraulics

EVER SINCE filtration won an accepted place in water purification the hydraulic design of filter beds has proceeded largely on an empirical basis. Especially has this been so with rapid filters, where the sand bed is stratified to a high degree and is hardly comparable with the homogeneous material whose hydraulic transmission capacity was studied during filtration's early years. Sand has frequently been specified in terms of its effective size and uniformity coefficient without any true knowledge of what a variation in these indexes might do to filter performance. Indeed, controversy has been active over the relative merits of high and low values of effective size. It has been apparent that more basic knowledge is needed on the hydraulics of filter beds.

An important contribution to the science of water treatment has been made by the Detroit experimenters whose work is reported in this issue. From their studies they have derived an expression for the friction loss occasioned by the passage of clear water through a bed of graded sand. It is true that filters do not deal with clear water, but a thorough knowledge of simple filter hydraulics necessarily precedes any study of the effects of coagulated turbidity. The expression now derived, moreover, is of value in enabling the designer to determine with a high degree of accuracy the initial loss of head through the sand bed. Further, to the extent that hydraulic behavior during a filter run is related to the initial loss, the effects of variations in grain size become subject to rational prediction.

It is reasonable to expect that the numerical values of the various coefficients in the formula may be revised in the light of future work by other experimenters, but the worth of the present work lies deeper than the numbers contained in the formula. Its most important aspect is the demonstration it gives that each stratum of the bed must be considered when studying the hydraulic properties of the bed as a whole, for each stratum is shown to contribute to the total loss in proportion to its depth and inversely as the 1.89th power of its grain size. Thus, effective size is found to be unsatisfactory as a general criterion of hydraulic behavior, as its use in connection with a stratified filter, for which it was not designed, requires that the loss of head be controlled by the size of the grain that lies at one-tenth the depth of the bed. In other words, it is necessary to assume either that variations in grain size in the higher and lower strata are of no consequence in determining hydraulic properties, or that such variations compensate for each other with the gradings commonly found in sands suitable for filter use. The Detroit tests show that neither of these assumptions is valid; sands of the same effective size may differ greatly in hydraulic behavior. Inclusion of all the size fractions thereby becomes imperative in drafting specifications for the purchase of filter sand. The present work is another step forward in putting filter design on a rational basis.

Late and Strange

AN ASTONISHING piece of redefining was done by the legal staff of the Reconstruction Finance Corporation when it declared, two weeks ago, that benefit assessments are not benefit assessments but are taxes. As is well known, taxes are uniformly distributed levies by government bodies to pay for general government cost and other services and structures of general public usefulness, while benefit assessments are specially allocated charges in reimbursement of the construction cost of local improvements.

Such reimbursement of the cost of a project by collecting part of the benefits which the improvement creates is an old and well-known device in carrying out improvements that affect a group of properties, and to the common man's understanding it is about as far removed from taxation as well can be. But the R.F.C. lawyers with legal finesse not only found a way to look upon benefit assessments as taxes but quite gratuitously denounced them as "possibly the most obnoxious form of taxes."

Benefit assessments were not regarded as taxes by the R.F.C., and were not considered obnoxious when the corporation approved loans to irrigation and reclamation projects that depend on such assessments for their returns. As no word has been received to indicate that these approvals may be revoked, it is possible that the directors do not see eye to eye with their legal subordinates. Nevertheless the legal finding is harmful, since it will further unsettle and obstruct prospective loan applications for self-liquidating projects.

But an even worse feature of the decision is the unaccountable delay in promulgating it. A decision, right or wrong, was needed early in August if quick action was to be secured in creating employment through the Relief Act. When the act was passed, four months ago, the eligibility of benefit assessments was known to be among the points requiring immediate interpretation to permit applications to go forward. The corporation nevertheless managed to leave this simple question undecided for three and a half months. Through such delay in the many questions with which the Relief Act confronted city, state and county authorities the country over, the R.F.C. has made the act an utter failure in relieving the hardships of unemployment this winter.

NEWS OF THE WEEK

Vehicle Limitations Recommended by Highway Officials

RESTRICTIONS of gross weight, dimensions and speed of vehicles operating on the highways were recommended at the recent meeting of the American Association of State Highway Officials. The recommended limits are as follows:

Width—No vehicle shall exceed a total outside width, including any load thereon, by 8 ft. except vehicles now in operation which, by reason of the substitution of pneumatic tires for other types of tires, exceed the above limit.

Height—No vehicle unladen or with load shall exceed a height of 12 ft. 6 in.

Length—No vehicle shall exceed a length of 35 ft. extreme over-all dimension, inclusive of front and rear bumpers. Combinations of vehicles shall consist of not more than two units and, when so combined, shall not exceed a total length of 45 ft. The truck tractor and semi-trailer shall be construed to be one vehicle for the purpose of determining lengths. For occasional movements of materials or objects of dimensions which exceed the limits herein provided, a special permit shall be required.

Speed—No motor vehicle shall be unnecessarily driven at such a slow speed as to impede or block the normal and reasonable movement of traffic except when reduced speed is necessary for safe operation or when a vehicle or a combination of vehicles is necessarily or in compliance with law proceeding at reduced speed. No bus or truck shall be operated at a speed greater than 45 miles per hour. Passenger automobiles may be operated at such speeds as shall be consistent at all times with safety and the proper use of the roads. Vehicles equipped with solid-rubber or cushion tires shall be operated at a speed not in excess of 10 miles per hour.

Axle Load—The wheels of all vehicles, including trailers, except those operated at 10 miles per hour or less, shall be equipped with pneumatic tires. No wheel equipped with high-pressure, pneumatic, solid-rubber or cushion tires, shall carry a load in excess of 8,000 lb., or any axle load in excess of 16,000 lb. Research indicates that low-pressure pneumatic tires can carry 9,000 lb. per wheel without increasing pavement slab stresses. An axle load shall be defined as the total load on all wheels whose centers may be included between two parallel transverse vertical planes 40 in. apart.

These limitations are recommended for all main rural and intercity roads, but should not be construed as inhibiting heavier axle loads in metropolitan areas if any state desires.

These weight specifications for wheel and axle loads may be restricted by the state highway department for a reasonable period where road subgrades are materially weakened from thawing after deep frost or from a continued saturated condition of the soil.

Gross Weights—Subject to the limitation imposed by the recommended axle loads no vehicle shall be operated whose total gross weight, with load, exceeds that given by the formula $W = c(L + 40)$ where

W = total gross weight, with load, in pounds

c = a coefficient to be determined by the individual states

L = the distance between the first and last axles of a vehicle or combination of vehicles, in feet.

A value of 700 is recommended for c as the lowest which should be imposed but this should not be construed as inhibiting greater values.

NOTE—This gross weight recommendation is particularly applicable to bridges since axle loads and length limitations are determinative in their practical application.

High Flood in Chagres River Delays Work on Madden Dam

Work on Madden Dam on the Chagres River in the Panama Canal Zone is reported to have been interferred with by the flooding of the cofferdam in the south side of the river channel. An unusually heavy rainfall resulted in a flood in the river estimated at 200,000 sec.-ft. on Nov. 28. Traffic through the Panama Canal was stopped during the day and 13 of the 14 floodgates in Gatun Dam were opened.

A recent report from A. J. Ackerman, chief engineer for the contractors on the dam, the W. E. Callahan Construction Co., and Peterson, Shirley & Gunther, stated that despite the coming of the rainy season work on the dam was progressing satisfactorily. Mr. Ackerman stated that the river cofferdam was designed to protect the work from all floods up to 50,000 sec.-ft.

On Nov. 8 of last year a somewhat similar flood occurred. At that time the maximum flow reached 250,000 sec.-ft. That flood was estimated to be somewhat worse than the one of Oct. 23-24, 1923.

Wilmette Water Works Project Held up by Injunction Petition

A petition asking for an injunction to restrain the Village of Wilmette, Ill., from proceeding with the construction of its 6-m.g.d. water works was filed in the Cook County circuit court Nov. 21. Awards were made Nov. 19, as noted in *ENR*, Nov. 24, p. 632, but contracts had not yet been executed. The R.F.C. has agreed to bid on the bonds of the village.

Shawnee Country Club, with a "Gold Coast" membership of 800 occupying a $500,000 club house opposite the site of the proposed plant, filed the petition. Allegations are that the site for the water works was recently rezoned for "public utility" purposes illegally, that the rezoning is an "unreasonable and arbitrary exercise of police power" and that it "bears no substantial or reasonable relation to the public health, safety, morals or general welfare." Some of the activities of the water works which the club claims will damage its property are the following: That the diesel and oil-burning engines (none of which are included in the award made Nov. 19) will create dirt, smoke and soot nuisance, preventing the club from serving meals out of doors on one of its verandas. That trucks delivering supplies and carrying off refuse and workmen parking cars in the vicinity will block traffic impairing the accessibility to the club. That the trucks will be noisy and create vibrations. That the plant will shut off a view of the lake from the club and destroy a portion of the bathing beach.

The question at issue relates almost entirely to the right of the village to utilize a piece of lake front property purchased in 1900 for public use and subsequently used for park and bathing beach along with adjacent riparian property acquired by a park board.

Loan of $965,000 For Four Projects Made by R. F. C.

LOANS of $965,000 for self-liquidating projects were approved by the directors of the Reconstruction Finance Corporation on Nov. 23. The principal amount authorized was a loan of $600,000 to the Tampa-Clearwater Bridge Co. of Tampa, Fla., for the construction of a toll bridge to connect Tampa and Clearwater. The R.F.C. will take 6 per cent notes of the company maturing serially in from two to ten years. The distance across the bay from Tampa to Clearwater is about 9 miles. Of this, 3,500 ft. will be viaduct and the remainder a causeway, the causeway requiring 5,000,000 cu.yd. of filling and 31,000 cu.yd. of lime rock protection. The viaduct will be of reinforced concrete and creosoted timber.

A loan of $250,000 to Drainage District No. 7, Marked Tree, Ark., at 5½ per cent interest, will be made by the R.F.C. for the completion of a project now about 35 per cent completed. It consists of levees for a floodway from the southern end of Lake Francis to the southern limit of the district, also for an auxiliary floodway. The other two loans approved by the R.F.C. were $35,000 through the purchase of bonds of the Kenton County (Kentucky) Water District No. 1 on a 5½ per cent interest basis for the construction of a 600,000 gal. capacity storage reservoir and for water main construction; and to the township of Denville, N. J., through the purchase of $80,000 6 per cent 6-year bonds for the enlargement of the township's waterworks.

Pending Applications

The Richmond-Hopewell Bridge Co. of Virginia plans to apply to the R.F.C. for a loan of $50,000 for the construction of a toll bridge across the James River near Dutch Gap. The Federal Bridge Co. of Washington, D. C., is the engineer.

Application for loan to finance the construction of a $3,000,000 bridge to connect Tacoma, Wash., with the Olympic Peninsula is to be made by the holders of the state franchise to construct such a bridge. Elbert H. Chandler, Tacoma, is reported to be backing the project.

The state of Wyoming has objected to a proposal of the Laramie Poudre Irrigation Co. to borrow $900,000 from the R.F.C. for the enlargement and expansion of its irrigation system in the Laramie River valley of Colorado.

A new obstacle to the proposed $28,000,000 loan from the R.F.C. to the city of Detroit, sought as a means of expediting five important street widenings, has developed in that the gasoline and weight tax receipts, offered as collateral, already have been pledged in connection with welfare relief loans.

The City of Richmond, Ky., has been denied a $40,000 loan for repairing and

extending the city owned gas system. The city sought to have R.F.C. purchase $40,000 worth of water revenue bonds, issued when water and gas plants were purchased from the Union Water Works Company's bond holders committee, but which were not sold. The issue was $460,000, but $70,000 of the bonds were not needed at that time.

The first money actually advanced by the Reconstruction Finance Corp. for self-liquidating projects, in the amount of $360,000, has gone to the Middle Rio Grande Conservancy District. This is part of a loan of $5,784,000 authorized some time ago.

Colorado River Board Makes Final Report

The Colorado River Board, appointed in July, 1928, by the Secretary of the Interior under authorization of Congress, made its final report on the Hoover Dam project on Nov. 19 and was thereupon disbanded by the Secretary. As originally appointed, the board consisted of Major Gen. William L. Sibert (retired), chairman, Daniel W. Mead, Charles T. Berkey, Warren J. Mead, and Robert Ridgway. Major General Sibert recently resigned from the board, and Prof. D. W. Mead acted as chairman of the board at its final meeting, held in Denver during November.

The final report of the board gives its approval to the work being carried on by the engineers of the Bureau of Reclamation in developing the detailed designs for Hoover Dam. The maximum section of the dam shown in the contract drawings is approved by the board as well as the minor changes made in other details of the dam as the result of intensive studies of the design carried on in the Denver office of the bureau. The changes result in a thickening at the abutments.

The board directs attention to the evidence of unusual soundness of the canyon walls produced by the excavation work which has been carried out, especially the work in the four diversion tunnels. This evidence resulted in the boards reaffirmation of its entire confidence in the rock and a recommendation that a minimum amount of excavation work be done in the preparation of the abutments. The board cautioned against heavy blasting in that work.

The work so far carried out in the river bed indicates that there also conditions superior to those anticipated will be encountered. The material is well graded and of relatively low permeability indicating that no unusual difficulties may be expected from that source in excavating for the foundations.

Extensive grouting and protective work in excavating for the spillways is recommended as the rock there encountered is not as sound as elsewhere. Similarly, protective work may be needed at the outlet of tunnel No. 1 on the Nevada side. The erosive effect of the river during diversion at this point will, according to the board, serve as a measure of the protection needed.

The board recommends that the tunnel which the contractor has driven beneath the floor of the gorge to serve as a drainage tunnel during construction be continued across the river and permanently maintained for observation of conditions under the dam, especially for studies of stress in the underlying rock after the dam is built.

Handling of Loan Applications Expedited by R.F.C.

To expedite the handling of self-liquidating applications a special board has been set up on which are representatives of the engineering, legal and financial divisions of the Reconstruction Finance Corporation. As applications are received they come to this board for a preliminary examination. In this way it is possible to request at once any additional information needed of a legal, financial or engineering character.

Formerly an application was referred first to the engineers. After it had been studied from an engineering standpoint it then was referred to the lawyers. It frequently was found that more information had to be sought on the legal end. This meant delay until that information was at hand. Under the present arrangement a material saving in time is expected and the time of the principal engineers, lawyers and financial experts reserved for the consideratoin of completed applications.

It is regarded as a foregone conclusion that the Reconstruction Finance Corporation Act will be amended in important particulars at the forthcoming session of Congress. An important amendment that will be brought forward is one which will define "full and adequate security." The idea of this amendment will be to liberalize the present interpretation of that requirement of the law. Other amendments will propose that loans be made under certain conditions to industry and to facilitate export trade.

Officials of the corporation are encouraged by the cooperation that has been pledged by the American Municipal Association. There is a feeling that if municipal officials will cooperate actively that a large aggregate of employment-producing money could be loaned in small amounts to a great many communities for improvement and extension of their water supply. A loan of that character can be approved without delay.

At the offices of the corporation it is explained that no prejudice exists there against revenue bonds. The directors believe that Congress meant what it said in the law about adequate security. This has not excluded revenue bonds where they really provide adequate security. Necessarily purchase of such bonds requires a more careful study than those backed by the full faith and credit of the community.

THREE-MILE VIADUCT NEAR NEWARK OPENED TO HIGHWAY TRAFFIC

The high-level viaduct which the New Jersey state highway department has been building over the Newark meadows, the Hackensack and Passaic rivers, during the past three years was opened to traffic on Nov. 24. This three-mile structure is the principal element remaining in the state highway department's program for improving the approaches to the Holland Tunnel for highway traffic to New York from the South and West. Before the work was started traffic had to pass through the congested centers of Elizabeth or Newark and frequently was completely stopped for long periods by opening of the draw spans over the Hackensack and Passaic rivers.

From the outskirts of Elizabeth to the west portal of the Holland Tunnel, a distance of about 13 miles, the new highway passes over all railway yards and most of the major highway or street crossings, nearly five miles being on viaducts having a minimum roadway width of 50 ft. The section just opened rises to clear the navigable channels of the Hackensack and Passaic rivers by 135 ft., thus avoiding the use of draw spans. At its eastern end the newly-opened viaduct connects with a depressed roadway passing under Jersey City Heights which in turn connects with a viaduct over the railroad yards between the heights and the tunnel portals.

Except for some minor details yet to be completed, the opening of the viaduct over the meadows completes the highway department program for carrying traffic from U. S. Route 1 past the congested centers in the metropolitan district. There remains yet to be completed a viaduct across Weequahic Park between Elizabeth and Newark to open the new traffic route to traffic to and from points in central and western Pennsylvania.

Construction of the new viaduct has been carried out under the direction of J. L. Bauer, state highway engineer, M. Goodkind, bridge engineer, F. Johannesson, designing engineer, and H. W. Hudson, engineer in charge of construction. The structure cost about $20,000,000.

The accompanying photograph of the viaduct was taken during the opening ceremony. In the background is the Hackensack River crossing. An air view showing the relation of the viaduct to the area west of the Holland Tunnel was published in the issue of Oct. 27, p. 511.

San Francisco Voters Pass and Reject Important Measures

Voters of San Francisco approved an ordinance at the November election which will go a long way toward improving the complicated problem of municipal garbage disposal. At the same time they defeated a proposed charter amendment which would have provided for issuing $5,000,000 of revenue bonds by the water department for much needed improvements in the system.

By vote of 102,436 to 36,197, the 1927 ordinance covering refuse collection and disposal was amended and replaced by an ordinance which includes the following principal points:

(1) The term "refuse," which according to the old ordinance applied to waste material from dwellings and apartments, was extended to cover discarded materials from stores, business houses and other establishments.

(2) The new ordinance authorizes the disposal of all waste and refuse including that having commercial value, and provides that if not disposed of by the producer it may be delivered to refuse collectors and they are required to receive and remove such material. At present eating establishments dispose of table refuse for hog-feeding because of its commercial value. The ordinance is designed to obviate the problem which might result in a future change in the value of this class of garbage, obligating refuse collectors to provide for its removal.

(3) The 1927 ordinance required refuse to be disposed of at the municipal incinerator (recently closed by court injunction) and provided a maximum charge of $1 per ton. The new ordinance increases this maximum rate to $1.50 per ton.

(4) Dumping at sea as a means of refuse disposal is prohibited by the new ordinance.

(5) Rates for collection are to remain unchanged, but the supervisors are permitted each year by a two-thirds vote to revise the rates, provided that there shall be no increase. The new ordinance requires the printing of the rate schedule on receipts.

Among the improvements made in the refuse and garbage disposal problem of San Francisco by the new ordinance the most important is the increase in the rate for incineration. All plans for incineration in the past have been definitely blocked by the dollar-a-ton limit for this operation. Under the new ordinance incineration becomes a definite possibility.

Since the closing down of the old incinerator by court action several weeks ago, the city garbage is being disposed of by fill-and-cover on low tide-flat areas. This method is considered only a temporary expedient, as plans for incineration have been definitely proposed for several years.

The proposed charter amendment to approve revenue bonds for improvements in the water system was defeated by a vote of about 65,500 to 88,000. The amendment would have authorized the borrowing of $5,000,000 (maximum) by the water department, with the authority of the supervisors, for extensions, repairs and reconstruction. The defeat of this measure leaves serious problems to be solved by the Municipal Water Department in the maintaining and providing of the necessary improvements to the system.

Cement Makers Foresee Prospects of Better Business

MANUFACTURERS of portland cement from all over the country met in Chicago late in November for the Thirtieth Anniversary meeting of the Portland Cement Association. Members present expressed hopefulness that in 1933 construction in several fields would be materially advanced over recent low levels. Particular attention was given at the meeting to the rapidly developing market for cement in the field of sewage treatment, low-cost concrete pavement and low-cost fireproof homes.

Extension of sanitary services was covered by H. C. Delzell, sanitary engineer of the association, who said: "A recent nation-wide survey shows that there are more than 5,000 cities and towns of 1,000 or over that have no sewage treatment plants. Mr. Delzell pointed out that there are 43 states whose legislatures meet in regular session in January, 1933. Because of the self-liquidating provisions in the Emergency Relief and Construction Act, municipalities in most of these states cannot qualify for federal loans. Mr. Delzell added that a large number of states are planning to change their laws so that their municipalities may take advantage of federal assistance.

Charles F. Conn
Chairman of P.C.A. Board

J. R. Fairman, manager of the association's eastern offices, presented a paper on low cost pavements which called attention to ways in which concrete may enter more importantly into purely local roads. He reported on several experimental stretches of cement-bound macadam pavements built during the year. In these stretches, Mr. Fairman pointed out that methods of placement were being worked out which indicated that cement-bound macadam would soon deserve a place in road building along with its older brother, the single track concrete pavement, of which there are some 3,000 miles in use. Mr. Fairman stated that cost figures compiled in the experiments showed that cement bound macadam would be in large demand on lightly traveled roads. Mr. Fairman's paper and the ensuing discussion also gave consideration to concrete of reduced thickness for roads that carry a small volume of traffic.

That cement will play a leading part in home building of the future, was set forth by W. D. M. Allan, manager of the association's cement products bureau. Mr. Allan asserted that there was a definite trend toward the construction of fireproof homes and that this movement would be aided by the recognition lending agencies are now giving fireproof homes as against combustible homes. Mr. Allan said that lending agencies are now showing a willingness to give larger loans if the home is to be of fireproof construction. The slight increase in original costs are compensated for by the savings in maintenance, Mr. Allan explained. He stated further that contractors who specialize in fireproof homes can now build them for as little as five to seven per cent more than the cost of combustible homes.

The convention was presided over by E. J. Mehren, president. Wm. M. Kinney, vice-president and general manager, delivered a paper which covered trends in highway financing. F. R. McMillan, director of research, spoke on the future of vibrated concrete.

The Thirtieth Anniversary of the association was commemorated at a special dinner at which Robert W. Lesley, a founder of the association and its first president, was a guest of honor. Because of its organization in 1902, the Portland Cement Association ranks as one of the oldest trade associations in the country.

Charles F. Conn, president of the Giant Portland Cement Co. of Philadelphia, was elected chairman of the board of directors. Mr. Conn was born in Concord, N. H., in 1865 and graduated from the civil engineering department of Dartmouth College in 1887. From 1887 to 1901 he was with the New Haven R.R. In 1901 he went to Westinghouse, Church, Kerr & Co. for the construction of the Lackawanna & Wyoming Valley R.R. and upon completion of that project he remained with the railroad until 1913 as vice-president and general manager.

In 1913 Mr. Conn entered the cement industry as president of the Grant Cement Co., a company resulting from the reorganization of the American Cement Co. and the Norfolk Portland Cement Co. At the present time he also is chairman of the board of the National Building Units Corp.

Exhibition of Bridge Designs

An exhibition of bridge designs will be held at the galleries of the Architectural League of New York, 115 East 40th St., from Dec. 2 to 30. This exhibition will include a group of photographs from the extensive collection of Wilbur Watson of Cleveland, illustrating the development of bridges from ancient to modern times. The exhibit will also include modern works of Lindenthal; Modjeski; Ammann; Steinman; Gehron; McKim, Mead & White; Westchester County Park Commission; and others. This exhibition should be of interest not only to engineers but also to the public, as it illustrates the noticeable improvement which has been made in bridge design during recent years, part of which can be attributed to the collaboration of engineers and architects.

Bids Called for First Bonds for Los Angeles Aqueduct

Advertisement for bids on the first block of Colorado River aqueduct bonds to be offered for sale was to be authorized Nov. 25 by the board of directors of the Metropolitan Water District of Southern California. It was indicated by the board that the first block to be advertised would be in the amount of $2,016,000, regarded as sufficient to finance the first stages of construction of the proposed aqueduct. The Reconstruction Finance Corporation has pledged itself to bid on Colorado River aqueduct bonds up to the sum of $40,000,000.

Decision to advertise the bonds was made by the district board following the approval by the board of a contract with the city of Pasadena, Calif., for the purchase of the Pine Canyon dam and reservoir, now under construction by the city. Members of the Pasadena city board of directors were to approve the contract formally on Nov. 25. The city will complete construction of the dam and reservoir, at an estimated cost of $6,500,000, and the district will take it over for storage of Colorado River water in connection with the aqueduct project. At the time of transfer of ownership of the dam, the district will credit the city of Pasadena, a member of the district, with the amount of the purchase price to apply against the city's share of the Colorado River aqueduct project cost.

SOCIETY CALENDAR

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, Detroit, Mich., Jan. 16-18.

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention and road show, Detroit, Mich., Jan. 16-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS annual meeting, New York, N. Y., Jan. 18-21.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

AMERICAN TOLL BRIDGE ASSOCIATION, annual meeting, Camden, N. J., Jan. 16-17.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual convention, Detroit, Mich., Jan. 16-18.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 1-2.

HIGHWAY AND BUILDING CONGRESS participated in by twenty national engineering societies and trade associations, Detroit, Mich., Jan. 16-20.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Detroit, Mich., Jan. 16-18.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Ottawa, Ont., Feb. 7-8.

NATIONAL CRUSHED STONE ASSOCIATION, annual meeting, Detroit, Mich., Jan. 16-18.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Detroit, Mich., Jan. 17-18.

NATIONAL READY MIXED CONCRETE ASSOCIATION, annual meeting, Detroit, Mich., Jan. 18.

NATIONAL SAND & GRAVEL ASSOCIATION, annual meeting, Detroit, Mich., Jan. 17-18.

PORTLAND CEMENT ASSOCIATION, Detroit, Mich., Jan. 16-18.

THE TEXAS WATER WORKS SHORT SCHOOL will hold its fifteenth annual session at Temple, Texas, Jan. 16-18. The school is carried out under the auspices of the Texas Department of Health and Texas Section, Southwest Water Works Association.

Henry Pickering Walcott Dies, Pioneer in Sanitary Engineering

Henry Pickering Walcott, former chairman of the Massachusetts State Board of Health and of the Metropolitan Water Board and the active leader in many other public services, died at his home in Cambridge on Nov. 11 in his 94th year. He was born at Hopkinton in 1838, graduated from Harvard in 1858 and after taking a medical degree he entered the Army in 1861. Following the Civil War he was for a number of years a practicing physician at Cambridge.

Dr. Walcott entered the public service in 1881 becoming health officer of the State Board of Health, Lunacy and Charity where he continued until 1885. In 1886 he was appointed chairman of the State Board of Health which had been newly established as a separate department by the legislature of that year.

Realizing the importance of scientific and practical knowledge in dealing with problems confronting the board, an engineering department was at once established with the late Frederick P. Stearns as chief engineer, supplemented by a chemical department under the direction of Thomas M. Drown, later president of Lehigh University, and a biological department under the direction of William T. Sedgwick. An experiment station was established at Lawrence to study in a practical way methods for the purification of sewage and water the work at which was begun under the direction of Hiram F. Mills, a member of the board, with the late Allan Hazen, who was first chief chemist, and George W. Fuller as chief biologist.

Under Dr. Walcott's leadership plans for a system of metropolitan sewerage, prepared under the direction of the board, were adopted by the legislature in 1889.

In 1893 Dr. Walcott was chairman of a committee of the State Board of Health assisted by the late F. P. Stearns as chief engineer which devised the plan for a Metropolitan Water Supply for the City of Boston and its suburbs. Dr. Walcott was appointed a member of the Metropolitan Water Board established to carry out this work which included the construction of the Wachusset Reservoir.

He early became interested in the question of improving the condition of the Charles River estuary which lay in the center of the Metropolitan District and was affected by the tides for a distance of ten miles above its mouth. A joint board, of which Dr. Walcott was chairman, prepared a plan for the construction of a dam near the mouth of the river to hold the water at a constant level a little below high tide.

After 28 years as chairman of the State Board of Health Dr. Walcott declined a further appointment, but upon his retirement in 1914 he was appointed chairman of the Metropolitan Water and Sewerage board and continued to serve in that capacity until the board was abolished in 1919.

In the meantime an additional water supply for the Metropolitan District became necessary and the legislature directed an investigation for an additional supply by the State Department of Health and the Metropolitan Water and Sewerage board which was begun under the direction of a committee of which Dr. Walcott was chairman and which he continued to serve as an adviser after retirement from the Metropolitan Water and Sewerage board. This project is now being carried out in accordance with plans envisaged by him at the time the original Metropolitan Water supply system was adopted in 1895.

Beside the service rendered to the State Board of Health and the Metropolitan Water and Sewerage board Dr. Walcott was the active leader in many services for the improvement of public health and welfare. He secured the cooperation of Harvard University in the free production and distribution of diptheria antitoxin begun in 1895 which lead as the result of his insistence to the adoption of this service by the state.

Personal Notes

JOHN A. ADAMS, junior engineer, U. S. District Engineer Office, Louisville, Ky., has been promoted to assistant engineer in charge of lock and dam design and transferred to Chattanooga, Tenn.

W. D. SHANNON, Pacific Coast general superintendent and Northwestern manager for the Stone & Webster Engineering Corp. of Boston, has severed his connection with that organization and has entered into private practice under the name of Shannon Engineering Co. with headquarters at Seattle, Wash. Associated with Mr. Shannon are four former Stone & Webster men, W. L. RICHARDSON, structural engineer; W. K. SANDERS, mechanical engineer; O. P. SEIM, structural engineer, and O. A. DEMUTH, electrical engineer. Mr. Shannon recently was named as one of the local engineering advisers to the Reconstruction Finance Corporation.

Obituary

GEORGE W. WHYTE, for many years an engineer on the United States Geological Surveys, died in Denver, Nov. 24, age 72 years.

SEABURY S. GOULD, vice-president and secretary, Goulds Pumps, Inc., Seneca Falls, N. Y., died at his home there on Nov. 25, age 45.

P. L. LECHNER, formerly head of the Western Construction Co., died at Los Angeles, Calif., on Nov. 26, age 60 years. Mr. Lechner was a native of Buffalo, N. Y., going to the Pacific Coast following the earthquake in San Francisco to take up construction work there.

CHARLES ANDREWS BARTON, civil engineer and chief land inspector for the Prudential Life Insurance Co., died at his home in Memphis, Tenn., Nov. 23, age 67. Mr. Barton was a graduate of Vanderbilt University and for many years was associated with T. L. Dabney on flood prevention work on the Mississippi River.

ROBERT S. ROCKWOOD, dean of the engineering school at the University of New Mexico from 1929 to 1931, died at Albuquerque, N. M., on Nov. 23, age 50 years. Professor Rockwood was a graduate of Denison University and received his master's degree from the University of Michigan.

City Planning Course Expanded

In recognition of the constantly growing interest in governmental problems in the Philadelphia metropolitan area, the University of Pennsylvania has expanded its graduate course in city government. Special attention will be given to methods of obtaining cooperation in a metropolitan district where essential public services overlap governmental boundaries. Development of transportation by rail, highways, and air; methods of expediting and controlling highway traffic; water supply and sanitation; parks and recreational facilities; zoning, housing and regulation of public utilities will be studied. Methods of financing public works programs, budgeting, city-state financial relations and reorganization of local government also will be dealt with.

Allotment of $1,670,000 Made for River and Harbor Work

An allotment of $1,670,000 from the funds for river and harbor work provided in the Emergency Relief and Construction Act of 1932 was approved by the Secretary of War on Nov. 25. The money is distributed as follows: construction of lock and dam No. 1 in the development of the Green and Barren rivers and Bear Creek, Kentucky, $800,000; intracoastal waterway from Jacksonville to Miami, Fla., $375,000; channel in Lake St. Clair, Mich., $410,000; Mobile harbor, Alabama, $85,000. The allotment of this money was made possible by the savings in contracts let from the total of $30,000,000 previously allotted under the Relief Act.

Large contracts among those for river and harbor work approved by the Chief of Engineers on Nov. 18 include $144,384 to the Great Lakes Dredge & Dock Co. for the construction of a stone sea slope on the lake side of about 3,000 ft. of the old breakwater at Buffalo harbor, New York; $427,406 in six separate contracts for earthwork on the right bank of the Mississippi River in the lower St. Francis levee district; and $274,550 to the firm of Kern & Kibbe of Portland, Ore., for construction of a rubble mound south jetty at the mouth of the Umpqua River in the Portland district.

A contract for dredging in the Delaware River at the Port Richmond anchorage let to the Standard Dredging Co. of New York for $503,980, and to the same company for dredging in the south end of Little River to Winyah Bay in the intracoastal waterway for $326,699 were among other contracts approved by the Chief of Engineers. A contract for the construction of a lock at lock and dam No. 20 on the Mississippi River at Canton, Mo., let to the Maxon Construction Co., Inc., of Dayton, Ohio, for $793,488, also was approved.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Dec., 1931	Four Weeks	Week Dec. 1, 1932
Federal government	$ 3,325	$ 6,548	$ 9,476
State and municipal	11,974	14,421	4,975
Total public	$15,299	$20 969	$14,451
Total private	9,727	4,074	4,876
Week's total	$25,026	$25,043	$19,327

Cumulative, Jan. 1 to date:

1931 construction	$2,354,072
1932	1,135,276

Decrease, 52 per cent.

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Weekly Average Nov. 1931	Four Weeks	Week Nov. 26, 1932
R.F.C. loans	.....	$3,200	$ 965
New capital issues	$17,000	7,400	5,200
Total	$17,000	$10,600	$6,165

Cumulative, Jan. 1 to date:

1931 new capital	$1,992,000
1932 R.F.C. loans approved	$137,264
1932 new capital	745,700
1932 total	$882,964

Decrease, 56 per cent.

ENR Cost and Volume Index

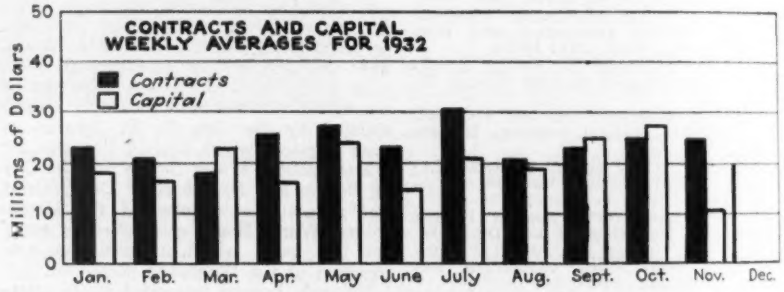
Cost		Volume	
December, 1932	**158.46**	**November, 1932**	**137**
November, 1932	158.20	October, 1932	137
December, 1931	166.23	November, 1931	180
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

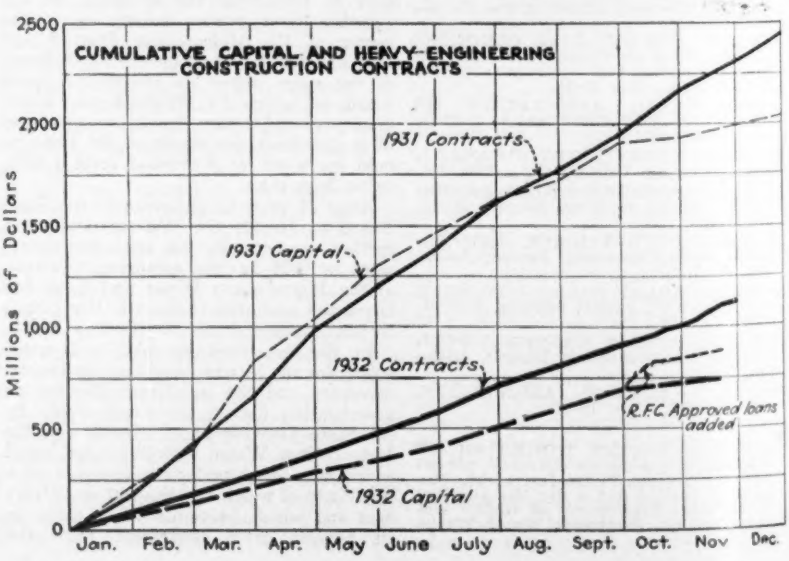
Engineering Contracts and Capital

HEAVY ENGINEERING construction contracts reported for the past week total $19,327,000, a considerable gain over those reported the previous week, totaling $14,885,000. The 4-week running average of contracts is $25,043,000, equal to the weekly average of December of last year. Public works contracts let during the week total $14,451,000, a slight gain over the previous week. Private contracts jumped 3 millions, amounting to $4,876,000. Commercial building awards were the strongest in eight weeks, reaching $2,720,000. Public building contracts, amounting to $6,853,000, were the largest since September 15. A considerable gain was noted in federal lettings, this class of work amounting to $9,476,000 for the week. Highway lettings showed the effect of the approaching winter season, falling to $3,594,000, the smallest figure since spring.

Large contracts reported include a million-dollar award for air conditioning in the RCA building, New York; federal court house and appraisers stores, Philadelphia, $2,574,000; Lock No. 4, Mississippi River, $836,000; and a postoffice, Norfolk, Va., $1,034,000. Proposed projects announced during the week include a theological seminary, Darlington, N. J., $2,000,000; postoffice, New York City, $6,350,000; waterworks, Toledo, $8,000,000; housing development, Toledo, $4,000,000; brewery, New York, $2,500,000; apartment, Newark, N. J., $1,000,000.

New capital issues reported for the week total $5,165,000, all public issues. The largest single issue was for schools and public improvements, White Plains, N. Y., $2,534,000. Four Reconstruction Finance Corp. self-liquidating loans were announced, totaling $965,000.

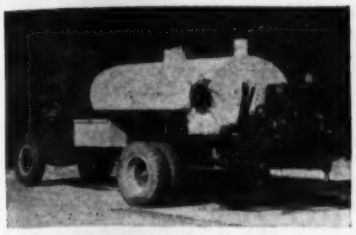




Construction Equipment and Materials

New Pressure Distributor For Bituminous Material

The addition of a pressure distributor to its present line of road maintenance equipment is announced by Littleford Bros., 415 East Pearl St., Cincinnati, Ohio. Standard sizes are available in 500, 600, 800, 1,000, 1,200 and 1,500 gallon capacities and can be mounted on a truck, trailer or semi-trailer, being adjustable to the chassis. An important feature of the Littleford distributor is its single valve control. The Littleford Six-Way valve is controlled from



Bituminous distributor by Littleford Bros.

a hand wheel which is marked "fill," "circulate," "spray," and "drain." This hand wheel is directly in front of the operator. Every operation is controlled from the operator's platform. A Viking rotary pump pumps bitumen to and from the control valve. This pump is driven by a 4-cylinder engine and is driven at a speed to product 150, 200 or 250 gallons per minute.

The heating unit consists of a low pressure oil burner, a fuel pump, 40 gallon fuel tank and a ball-bearing blower. Both fuel pump and blower operate from the distributor engine.

New Equipment in Brief

Dump Trailer. A new crawler wagon known as the Forged-Trak bottom dump trailer has been announced by the Athey Truss Wheel Co., Chicago, Ill. The new trailer comes in 5, 6, 7 or 8 yd. capacities for service with elevating grader, shovel or dragline. It is featured by a one-piece box-section arch drawbar, with an adjustable and reversible spring-mounted, spring-cushioned, swivel-type tractor hitch. The track assembly has an interlocking self-cleaning structure. The track pin bearing is of the pin and bushing type. The body is of ¼ in. steel plate with 4 in. bulb angles and cast steel corner brackets.

Rust Remover. A compound which removes rust, scale and foreign matter from metals and impregnates the metal itself to prevent further deterioration is being manufactured by the Witty Laboratories, Inc., 10-33 47th Ave., Long Island City, N. Y. The material is known as Napolite. It is a flexible, elastic coating compound which acts as a rust-proof and non-corroding subcoating or base for iron, steel, copper, brass, aluminum and sheet metal. The manufacturer states that it is particularly adapted for use on railroad cars and equipment, bridges, structural steel, oil tanks, pipe lines, ship building and metals of all kinds.

Portable Conveyor. A new model portable belt conveyor is announced by Link-Belt Co., Philadelphia, Pa. It incorporates fixed steel retaining sides extending over the entire length of the conveyor, thus preventing lumps from spilling over the sides of the belt at any point. The foot end has been designed to keep material away from the return run of the conveyor belt. The machine is suitable for the economical loading or unloading of any loose material.

Crushing and Screening Plant. A portable crushing and screening plant of the unit type has been developed by the Stephens-Adamson Mfg. Co., Aurora, Ill. The plant consists of a number of standard units designed for quick assembly in different combinations to suit the particular job or deposit in which the operator is interested. These units consist of receiving hopper and feeder, crushing unit, screening unit, storage hoppers and complete belt conveyor units. Each unit is self-contained, comparatively light and easy to move. The plant is designed to handle a wide variety of deposits. The crushing unit is built to take one or two crushers of various makes, types and sizes. Likewise, the screening unit will mount a single, double or triple deck vibrator screen. Where washed material is required, water sprays are added above the vibrator screen and a classifier or dewatering unit is quickly inserted.

Business Notes

MONARCH MANUFACTURING CO., INC., Wilmington, Del., has acquired the property, plant and equipment formerly owned and operated by Remington Machine Co., located on East Front St., Wilmington, Del. The acquisition of the plant will enable the Monarch Manufacturing Co., Inc., to do any class of light or heavy machine work. They are also manufacturing a line of rock crushing and sand and gravel equipment, as well as snow plows and chip spreaders. Earle S. Philips heads the executive and sales departments. Harry E. Kind is in charge of the factory and engineering departments.

REX-WATSON CORP., Canastota, N. Y., announces that S. E. Ackerman has been appointed general sales manager in charge of both foreign and domestic sales.

AMERICAN HOIST & DERRICK CO., St. Paul, Minn., announces that Stanley H. Smith, Midland Bank Building, Cleveland, Ohio, has just been appointed their railroad representative in the Cleveland district.

CLEVELAND TRACTOR CO. and the AUSTIN-WESTERN ROAD MACHINERY CO. have completed a sales and service agreement for the distribution of Cletrac crawling tractors in Middle Western and Southern territory comprising the states of Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Nebraska, Iowa, Illinois, Indiana, Kansas, Eastern Missouri, Oklahoma, Texas, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, North Carolina, South Carolina, Tennessee (in part), Virginia and West Virginia. The Cletrac line will be on display in all principal cities and trading centers in this territory and will be sold and serviced through the combined efforts of the present Austin-Western organization and the industrial sales division of the Cleveland Tractor Co. The plan will not be extended beyond the territory indicated and similar working arrangements hitherto made by the Cleveland Tractor Co. in other territories, with other grader and road machinery companies, will not be disturbed.

New Publications

Brick Paving. The National Paving Brick Association, National Press Building, Washington, D. C., has published a 24-page booklet describing the application of paving brick to gutters and parking strips. The design and construction of brick gutters and parking strips in conjunction with bituminous paved streets are discussed and general specifications are provided. The booklet also includes reproductions of a number of letters from city engineers giving the results of their experiences with this material.

Electric Motors. Squirrel-cage induction motors, Type AA, manufactured by the Reliance Electric & Engineering Co., Cleveland, Ohio, are described in Bulletin 111, issued by that company. The booklet describes the manufacturing processes used in producing the motor as well as its electrical characteristics. The motor comes in sizes from ½ hp. to 200 hp.

Steel Flooring. The Robertson Keystone-Beam steel floor manufactured by the H. H. Robertson Co., Pittsburgh, Pa., is described in a publication issued by that company. The floor is a cellular structure taking the form of keystone-shaped steel beams. Each unit is built by preforming two steel sheets and subsequently welding these two sheets together in the plane of the neutral axis. Concrete fill is applied directly to the surface of the floor. Each unit as delivered to the job is either two cells wide, 12 in., or four cells wide, 24 in. The average unit weighs less than 250 lb. The booklet contains many data sheets giving the structural charateristics of the various units for use in design.

Air Filters. An illustrated 8-page bulletin describing its new Coppus Annis dry air filter for ventilating systems is now being distributed by the Coppus Engineering Corp., Worcester, Mass. In addition to installation diagrams and other illustrations, many reference tables and other technical data of interest to the ventilating engineer and contractor are included.

Traffic Lane Marking Machine

A new traffic lane marking machine involving a paint sprayer is being marketed by Spraco, Inc., 135 Central St., Somerville, Mass. The gun which lays the line is mounted between two solid disks in the center of the frame, which may be adjusted for any width of line from 3 to 10 in. The edges of the line are sharp and clean and a drip tray in the back prevents sloppy ends or puddling when the machine is stopped at the end of the line. Compressed air for operating the spray gun is supplied by a small gas-engine-driven compressor mounted on a small truck and carrying also a paint tanks.

Spraco machine for marking traffic lanes

Business Side of Construction

Golden Gate Bridge Contracts Hold Construction Volume Steady

HEAVY ENGINEERING construction contracts reported during November (four weeks) total $100,443,000, or 25.1 millions per week, as compared with 25.2 millions for October. Award of the Golden Gate bridge contracts was responsible for the maintaining of the unseasonal volume established in October. In other years the contracts awarded curve has dropped steadily from September through the end of the year. Emphasis given public works this year has resulted in a rise in contracts since September instead of the usual decline. Private contracts dropped from a weekly average of 5.2 millions in October to 3.4 millions for November. Public works increased from 19.5 millions per week in October to 21.7 millions for the month just closed. Highway lettings fell off from $9,700,000 per week to $7,500,000. The weekly average of public awards passed that of November, 1931, this being the first time that contracts of this class have caught up with those awarded for a similar period last year. Federal awards gained slightly over those of the previous month, averaging $6,170,000 per week. About half of this amount was for levee work, much of the remaining half being accounted for by new building contracts.

In the geographical distribution of contracts, the Far West showed a gain of 145 per cent, due to the Golden Gate awards. The Middle Atlantic section maintained its October figure, while all other sections showed decreases for the past month.

Geographical distribution of heavy engineering construction contracts reported in October, 1932 (four weeks) in thousands of dollars. Federal contracts are included in regular classifications, but are also shown separately as a matter of record. Below are shown weekly average contract awards, in millions of dollars, for various classes of work and for different sections of the country.

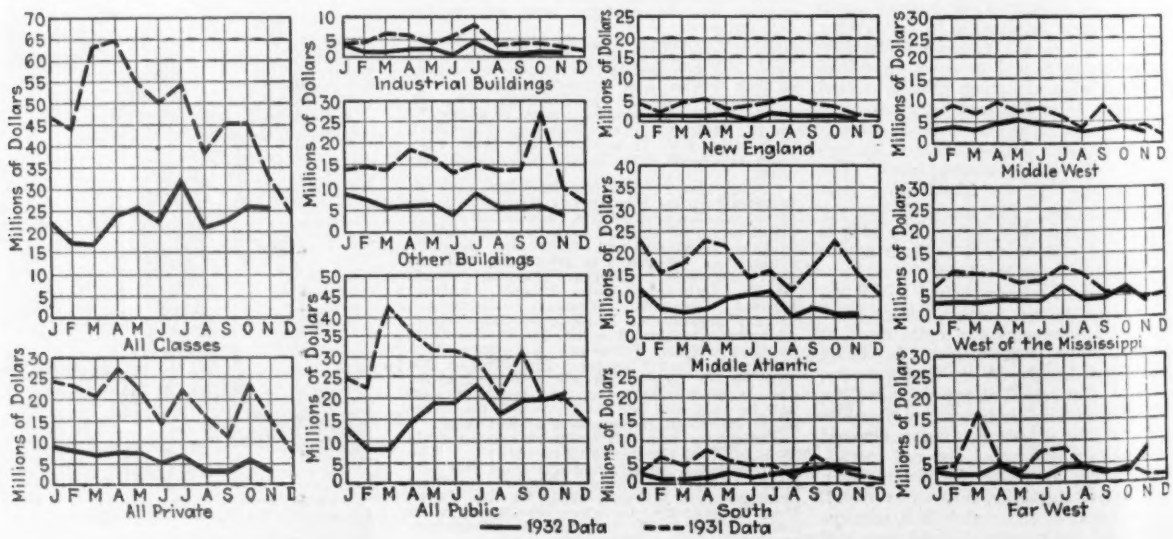
Cost index rises

The *Engineering News-Record* Cost Index for December registered a slight gain over the previous month, now standing at 158.46, as compared with 158.20 for November. A small rise in labor rates was responsible for the increase, as the three basic commodity prices used in the index showed no change. The average of the Index for the year is 156.97, as compared with 181.35 for 1931 and 202.85 for 1930.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN NOVEMBER, 1932
Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Nov., 1932	United States Eleven Months 1931	United States Eleven Months 1932	Canada Nov., 1932
Waterworks	9	27	60	435	325	410	1,266	53,999	25,402	1,272
Sewers	124	1,862	360	88	22	116	2,572	68,028	23,361	20
Bridges, public	41	178	21	693	1,453	24,560	26,946	118,915	73,416	2,634
Earthwork and waterways	346	2,576	4,656	1,919	2,922	860	13,279	20,080	93,955	.....
Streets and roads	1,162	3,971	5,528	4,687	10,513	4,207	30,068	502,065	350,133	429
Unclassified, public	117	251	26	84	184	443	1,105	80,995	36,855	477
Buildings, public	1,168	4,154	1,931	1,932	2,241	330	11,756	233,241	214,867	100
Total public	2,967	13,019	12,582	9,838	17,660	30,926	86,992	1,341,683	818,289	4,932
Federal government (included in above classifications)	1,056	5,337	6,647	3,761	5,457	2,816	25,074	264,340*	241,250	.....
Buildings, industrial	250	1,902	533	725	861	308	4,579	157,755	83,507	477
Buildings, commercial	25	6,430	.....	615	295	325	7,690	537,813	154,337	.....
Bridges, private	.....	142	.....	80	.....	.....	222	11,159	436	.....
Earthwork, private	.....	.....	40	40	.....	4	84	.....	934	.....
Unclassified, private	75	272	25	30	300	174	876	280 635	55,052	.....
Total private	350	8,746	598	1,490	1,456	811	13,451	987,363	297,660	4,455
November, 1932 (4 weeks)	**3,317**	**21,765**	**13,180**	**11,328**	**19,116**	**31,737**	**100,443**	.....	.....	**9,387**
October, 1932 (4 weeks)	5,285	23,319	17,551	15,824	25,334	13,499	100,812	.....	.....	1,139
November, 1931 (4 weeks)	9,145	67,226	9,300	27,487	17,922	7,678	138,758	.....	.....	24,563
Eleven months, 1932	68,756	367,683	112,803	188,403	219,278	159,026	.....	.....	1,115,949	48,488
Eleven months, 1931	173,533	915,892	226,188	361,685	371,179	280,568	.....	2,329,045	.....	125,094

* Not included in other classifications.



The *ENR* Volume Index remained stationary for November, standing at 137, the same as for October.

Materials notes

Steel—Production of steel during November held closely to 20 per cent of capacity, with individual mills varying from 10 to 45 per cent. Expected gains during the month did not materialize. Steel prices remained unchanged in the structural, plate and bar classes. The industry holds out hope for increased buying in December on the part of railroads and structural fabricators.

The October report of the American Iron and Steel Institute shows an output of 1,018,649 tons for that month, as compared with 929,526 tons for September, for all companies reporting. An estimate of the output of all companies raises the October output by 50,000 tons. The October production is given as 19.0 per cent of capacity. Estimated output for the ten months of 1932 amounts to 11,236,315 tons, just about half of the production for a similar period last year. Output for the ten months is rated at 19.98 per cent of capacity.

Lumber—Production of lumber during November was about 22.3 per cent of normal, and 41 per cent of the average of the past three years, according to the National Lumber Manufacturers Association. For the first 46 weeks of the year, production was 22 per cent of normal and 39 per cent of the three year average. November showed the usual seasonal decline in the lumber business.

The Timber Conservation Board reports that, in line with its continued recommendations, lumber stocks have been reduced more than 4½ billion feet since the latter part of 1930, and 800 million feet since July 1, 1932. Continuing low consumption is reported to have prevented the restoration of an even balance between lumber supply and demand. From a total of 35.8 billion feet in 1929 lumber demand has fallen to an annual demand of 12 billion feet during the first nine months of 1932. The downward trend in lumber prices was reported checked in September.

Building Stone—Building stone sold in 1931 amounted to 21,461,440 cu.ft., a decrease of 29 per cent from the 1930 sales, according to the U. S. Bureau of Mines. More than half of this amount, or 11,706,840 cu.ft., was limestone, valued at $10,857,697, a loss of 25 per cent over 1930. Granite sales amounted to 5,392,420 cu.ft., and sandstone, 2,289,440 cu.ft. Marble sales in 1931 were 1,661,350 cu.ft.

Cement—The Bureau of Mines reports that the portland cement industry in October, 1932, produced 7,939,000 bbl., shipped 8,743,000 bbl. and had in stock at the end of the month 17,074,000 bbl. Compared with October of last year, production decreased 26.2 per cent, shipments decreased 29.3 per cent and stocks decreased 19.5 per cent. Production in October is rated at 34.6 per cent of capacity, as compared with 36.9 per cent for September and 47.4 per cent for October, 1931.

Labor notes

Few basic changes in wage scales were reported during November. The San Francisco Impartial Wage Board set new scales to become effective Jan. 1, which are about 20 per cent below existing official wage scales, though the construction industry had made such a reduction in many trades some time ago.

New York—The upward trend in employment, started in August, has continued through September and October. A slight falling off of construction employment was noted in October. During the second week in November 11.42 miles of highway were built in the state, the greatest weekly mileage in seven years. More than 14,000 workers were employed at that time on highway building, of which 8,864 were in the employ of contractors.

St. Louis—About 45 per cent of building trades workers are reported unemployed, with 25 per cent more on part time work only. There are continued reports of workers accepting wages below prevailing scales, but individual cases are hard to find.

Illinois—Winter highway construction in Illinois will provide work for 13,750 men for 85 days. The payroll is estimated at $1,245,133. Projects costing $4,150,000 will be built this winter.

San Francisco—Work on city construction jobs totaling $3,000,000 will be under way by the first of the year.

Denver—D. & R. G. W. R.R. officials state that more than 1,000 men will be put to work shortly on the Dotsero cutoff construction.

Oklahoma City—Municipal construction projects are giving employment to 1400 emergency relief workers.

California—State work camps will be established soon in 43 locations to take care of single and homeless workers. They will have a capacity of 6,250 men, who will work in exchange for shelter, food, clothing and tobacco.

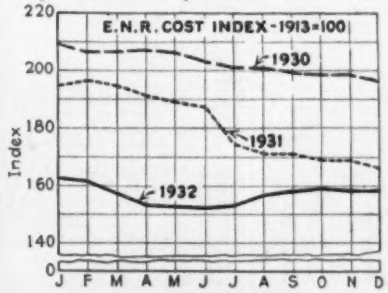
Indiana—The state highway commission has reduced the minimum wage on road work from 40 to 35c per hour.

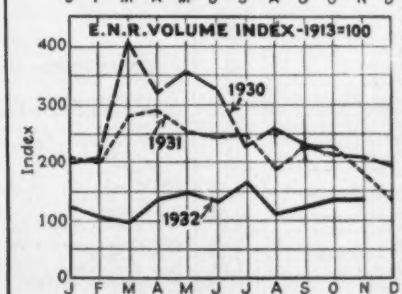
CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta	$0.75@1.12½	$0.40@.90	$0.60@1.25	.....	$0.60@1.25	$0.25	$0.20@.25
Baltimore	.62½@1.00	.65@.90	1.37½	$0.65	1.25	.40	.30
Birmingham	.75@.87½	.60	.75	.....	.75	.25	.20@.30
Boston	.90@1.30	.70@1.17½	1.00@1.17½	.70@1.07½	1.00@1.20	.45@.70	.40@.70
Cincinnati	.90@1.27½	.50@1.02½	1.07½	1.07½	1.06¼@1.20	.70	.40@.45
Chicago	1.37½	1.31¼	1.31¼	1.31¼	1.35	.82½	.50@.82
Cleveland	.90@1.37½	.75@1.12½	.90@1.12½	1.00	.90@1.06¼	.56¼	.30@.72
Dallas	.62½	.50	.50	.50	.50	.25	.25@.35
Denver	1.00@1.12½	.75@.87½	.75@.87½	.....	.75@.87½	.50	.31¼@.50
Detroit	.75@1.50	.55@.80	1.25	1.25	1.25	.70	.30@.50
Kansas City	1.30	1.12½	1.12½	1.06	1.12½	.82½	.35@.40
Los Angeles	.62½	.50	.75	.625	.625	.50	.35@.50
Minneapolis	.90@1.00	.75	.75	.....	.90	.50	.40@.50
New Orleans	.60@.80	.40@.50	.80@1.12½	.90	.80@1.12½	.50	.15@.20
New York	1.50@1.65	1.25@1.40	1.50@1.65	1.50	1.65	.81¼@1.00	.50@.75
Philadelphia	1.00@1.25	.60@.90	1.00	.75	1.00	.30@.40	.20@.30
Pittsburgh	.60@1.50	.60@1.25	.60@1.37½	1.00@1.18¾	.60@1.37½	.50	.40@.70
St. Louis	1.50	1.25	1.35@1.47	1.25	1.47	1.00	.35@.78¼
San Francisco	1.12½	.90	1.00	1.00	1.20	.65	.65
Seattle	.75@1.20	.50@.90	1.00	.90	1.10	.66	.40@.50
Montreal	.75	.60	.55	.....	.70	.45	.25@.30

Construction Cost and Volume Index Numbers

A slight rise in the average of common labor rates boosted the Cost Index for December to 158.46, as compared with 158.20 for November. No change was reported in the prices of the three basic commodities entering into the Index. The average of the Index for the year is 156.97, as compared with 181.35 for 1931 and 202.85 for 1930. Except for a slight drop in November, the Cost Index has steadily increased since June. The Volume Index for November shows no change.





E.N.-R. Cost	
December, 1932	**158.46**
November, 1932	158.20
December, 1931	166.23
1931 (Average)	181.35
1930 (Average)	202.85
1913 average	100.00
1931	
January	194.48
February	196.61
March	194.51
April	191.63
May	189.33
June	187.23
July	174.37
August	171.38
September	171.40
October	169.78
November	169.28
December	166.23
1932	
January	162.48
February	161.82
March	157.24
April	153.12
May	152.78
June	152.20
July	153.36
August	156.80
September	157.96
October	159.16
November	158.20
December	158.46

E.N.-R. Volume	
November, 1932	**137**
Oct., 1932	137
Nov., 1931	180
1931 (Average)	220
1930 (Average)	260
1913 average	100.00
1931	
January	208
February	198
March	278
April	289
May	251
June	243
July	248
August	187
September	225
October	229
November	180
December	133
1932	
January	121
February	105
March	97
April	135
May	149
June	131
July	166
August	111
September	124
October	137
November	137

Current Prices of Construction Materials

Building Materials

PORTLAND CEMENT — Prices are for carload lots. For cement in returnable cloth bags add 40c. per bbl.; in non-returnable paper bags add 15c. per bbl., to following net prices:

	F.o.b.	Delivered		F.o.b.	Delivered
Atlanta	$2.33	$2.85	Kansas City	$1.60	$1.70
Baltimore	....	2.03	Los Angeles	2.10	2.10
Birmingham	2.02	2.12	Minneapolis	2.10	2.25
Boston	1.58	1.68	Montreal	1.70	....
Chicago	1.60	1.95	New Orleans	1.90	2.20
Cincinnati	1.37	1.52	New York	1.59	1.80
Cleveland	1.72	1.95	Philadelphia	1.84	1.94
Dallas	2.80	3.00	Pittsburgh	1.68	1.78
Denver	....	2.40	St. Louis	1.64	1.95
Detroit	1.47	1.80	San Francisco	2.05	....
			Seattle	2.55	2.70

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four bags, f.o.b. Bag charges same as in preceding table:

Alpena, Mich	$1.20	Mason City, Ia	$1.35
Buffington, Ind	1.25	Norfolk, Va	1.61
Dallas, Tex	1.75	Northampton, Pa	1.40
Hannibal, Mo	1.25	North Birmingham, Ala	1.60
Hudson, N. Y	1.50	Richard City, Tenn	1.70
Independence, Kan	1.35	Steelton, Minn	1.45
Ironton, Ohio	1.06	Universal, Pa	1.21
Iola, Kan	1.35	Waco, Tex	1.75
La Salle, Ill	1.25	Wyandotte, Mich	1.20
Limedale, Ind	1.25		

SAND AND GRAVEL — Per ton, carload lots, gravel, size ¾-in.:

	Gravel		Sand	
	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$1.95	$2.75	$1.50	$2.50
Baltimore	....	2.55	....	2.08
Birmingham, per cu.yd	....	3.00	....	2.40
Boston	1.40	1.65	.90	1.15
Chicago, per cu.yd	....	2.25	....	2.25
Cincinnati	1.20	1.65	.95	1.40
Cleveland	....	2.00	1.40	2.00
Dallas, per cu.yd	1.40	2.40	1.65	2.40
Denver, per cu.yd	1.75	1.85	1.15	1.20
Detroit	.50	1.45	.72	1.50
Kansas City	.75	....	.60	....
Los Angeles	1.35	1.45	.85	1.00
Minneapolis	....	1.60	....	.65
Montreal	1.50	....	.80	....
New Orleans	1.50	2.50*	1.20	2.00*
New York, per cu.yd	1.60	3.25	1.00	2.00
Philadelphia	....	1.66	....	1.38
Pittsburgh	....	1.20	....	1.40
St. Louis	.25	1.15	.75	1.15
San Francisco	1.65	....	1.65	....
Seattle, per cu.yd	1.75	....	1.75	....

*Cu.yd.

CRUSHED STONE — Per ton, size 1½-in., carload lots, limestone:

	F.o.b.	Delivered
Atlanta	$1.95	$2.75
Baltimore	....	2.60
Birmingham	.80	1.05
Boston	1.40	1.65
Chicago, per cu.yd, 2,500 lb	....	2.25
Cincinnati	1.65	1.85
Cleveland	....	2.00
Dallas, per cu.yd., 2,500 lb	1.65	3.00
Denver, granite, per cu.yd., 2,700 lb	....	2.50
Detroit	1.09	1.95
Kansas City	1.25	....
Los Angeles	1.35	1.45
Minneapolis	....	1.60
Montreal	1.35	....
New York, per cu.yd., 2,800@3,000 lb	1.60	3.25
Philadelphia	....	2.00
Pittsburgh	....	2.25
St. Louis	1.35	1.65
San Francisco, trap rock	1.65	....
Seattle, per cu.yd., 3,000 lb	1.10	....

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Slag Sand
Birmingham	$0.90	$1.15	$2.05	$0.55
Buffalo	1.35	1.35	1.85	1.25
Cleveland	1.70	1.70	....	1.35
Toledo	1.20	1.20	1.20	1.10
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown	1.10	1.20	2.00	.75

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Birmingham (5x8x12)	$0.084	Kansas City	$0.18
Boston	.15	Los Angeles	.15
Brooklyn and Queens	.12	Minneapolis	.09
Chicago	.175	Montreal	.14
Cleveland	.165	New Orleans	.16
Denver	.15	Philadelphia	.15
Detroit	.08	Pittsburgh	.14
		St. Louis	.14

READY MIXED CONCRETE—Per cu.yd., 1:2:4, delivered 50 cu.yd. or more:

Atlanta	$7.75	Los Angeles	$5.40
Birmingham	4.90	Minneapolis	6.00
Boston	6.50	New Orleans	6.20
Cincinnati	6.10	New York (Manhattan)	8.50
Dallas	6.25	Philadelphia	5.98
Detroit 1:2½:5	4.75	Pittsburgh	5.75
Kansas City	7.50	St. Louis	6.15
		Seattle	5.35

HOLLOW TILE—Building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.09	$0.11	$0.13	$0.20	$0.25
Baltimore	.10	.14	.20	.22	.30
Birmingham	.089	.122	.167	.219	.25
Boston (at plant)	.075	.11	.14	.20	.30
Chicago	.0484	.063	.09	.1179	.15
Cincinnati	.06815	....	....	.165	....
Cleveland	.048	.066	.09	.117	.15
Dallas	.067	....	....	.173	....
Denver	.085	.135	.175	.19	.25
Detroit	.0505	.065	.0947	.1175	.1305
Kansas City	.0735	.092	.15	.1777	.20725
Los Angeles	.09425	.134	.188	.2325	.3115
Minneapolis	.0635	.09395	.1232	.13425	.2103
New Orleans	.085	.115	.16	.225	.255
New York	.075	.1164	.145	....	....
Perth Amboy	....	....	....	.2388*	.2956*
Philadelphia	.065	.093	.14	.175	.195
Pittsburgh	.0435	.065	.088	.1165	.126
St. Louis	.062	.088	.118	.16	.20
San Francisco	.0765	.105	.1765	....	....
Seattle	.085	.115	.18	....	....

*At plant. (Load-bearing tile).

BRICK — Prices per thousand in carload lots, as follows:

	Common Backing		Paving F.o.b.
	F.o.b.	Delivered	3x8½x4-in.
Atlanta	$8.50	$14.00	$32.00
Baltimore	....	11.50	43.00†
Birmingham	10.00	12.50	25.00
Boston	12.00	16.00	43.00
Chicago	....	9.00	32.00
Cincinnati	13.50	16.00	36.50
Cleveland	12.00	14.00	33.00
Dallas	11.00	12.50	25.00†
Denver	13.00	....	40.00
Detroit	11.50	12.50	25.00
Kansas City	12.00	13.00	35.00
Los Angeles	8.00	8.50	....
Minneapolis	....	7.50	....
Montreal	21.50	....	....
New Orleans	10.50	14.50	40.00
New York	9.50	12.50	45.00
Philadelphia	....	13.00	40.00
Pittsburgh	11.00	13.00	35.00
St. Louis	....	12.00	32.00†
San Francisco	....	14.00	45.00*
Seattle	12.00	14.00	....

*2½x8½x4 in. †3½x8½x4 in.

LIME — Prices of hydrated, per ton, in paper; lump, per 180-lb. bbl., net:

	Hydrated				Common Lump,	
	Finishing		Common			
	F.o.b.	Delivered	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$13.50	$18.00	$11.50	$15.50	....	$2.50
Baltimore	....	20.00	....	13.00	....	....
Birmingham	21.00	12.00	....	....	1.65	....
Boston	11.50	15.00	14.00	16.00	$2.35*	3.25*
Chicago	....	20.00	....	14.00	....	2.75
Cincinnati	10.00	11.00	8.65	9.65	....	....
Cleveland	10.50	14.00	8.50	12.00	....	2.50
Dallas	....	20.00	....	....	....	2.50
Denver	....	30.00	....	22.00	....	2.85*
Detroit	9.25	14.00	7.25	12.00	....	....
Kansas City	....	22.00	....	....	....	2.75
Los Angeles	24.00	26.00	17.00	18.00	....	2.00
Minneapolis	....	21.00	....	19.00	....	1.70
Montreal	....	18.00	12.00	13.00	....	....
New Orleans	14.75	22.50	11.50	14.00	1.66	1.95
New York	10.70	14.50	8.60	12.50	2.25*	3.15*
Philadelphia	11.50	15.39	9.90	13.49	....	1.18
Pittsburgh	11.50	13.00	10.75	12.25	1.85	2.35
St. Louis	....	.45‡	....	.40‡	....	2.15
San Francisco	19.00	....	19.00	....	1.59	....
Seattle	....	32.00	....	24.00	....	2.80

*Per 280-lb. bbl. (net.) ‡Per sack.

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:
New York:* Rustic buff, $1.48; Standard gray, $1.48; Standard buff, $1.58; Selected gray, $1.58; Selected buff, $1.68; Variegated, $1.48.
Boston: Rustic buff, $1.47; Standard, $1.57; Selected buff, $1.67.
Pittsburgh: Rustic buff, $1.14; Standard, $1.24 at quarry; Selected buff, $1.34.
Philadelphia: Sel. buff, $1.59; Sel. gray, $1.49; Standard, $1.49; Standard gray, $1.39; Rustic buff, $1.39.
Atlanta: Standard, $1.31.
*F.o.b. Bedford, freight allowed to N. Y.

SLATE—Roofing, f.o.b. quarry, Bangor, Pa., net, per square;

No. 1 Clear	$8.25@$9.50
No. 1 Ribbon	6.75@ 7.50
Medium Clear	7.25@ 8.00

Road and Paving Materials

PAVING STONE — Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	$3.00 per sq.yd.
Baltimore	43.00 per M.
Birmingham (3½x8½x4-in.)	76.25 per M.
Boston	90.00 per M.
Chicago, 5 in	3.80 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	95.00 per M.
Dallas	25.00 per M.
Detroit, 5 in	2.80 per sq.yd.
Kansas City	3.00 per sq.yd
Minneapolis, 4½ in	2.80 per sq.yd
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in	135.00 per M.
Philadelphia, 4x10x5	115.00 per M.
Pittsburgh	115.00 per M.
St. Louis, 5 in	2.75 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING — Prices f.o.b., in carload lots:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.10
Chicago	3½	12	1.90
Kansas City	3½	16	2.65
Minneapolis	3½	16	2.25
Montreal	3½	16	2.63
New York	3½	14	1.90
Philadelphia	3½	16	2.02
St. Louis	3½	16	2.10

CURBING—Per lin.ft., 5x16 in., straight, rough, f.o.b., in carload lots:

Atlanta	$0.41	New York	$0.62
Birmingham	.50	Philadelphia (6x20 dressed)	1.40
Boston	.70	Pittsburgh	.80
Dallas	.60	St. Louis	.65
Detroit	.45		

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$21.60	$17.40
Baltimore (f.o.b. refinery)	17.00	13.00
Bayonne (f.o.b. refinery)	17.00	13.00
Birmingham	.....	11.00
Boston	20.00	16.00
Chicago	22.50	15.50
Cincinnati (f.o.b. refinery)	.....	8.00
Cleveland	18.25	14.50
Dallas	.....	27.00
Denver	27.50	.....
Detroit	16.80	12.43
Kansas City (f.o.b. refinery)	16.00	.....
Los Angeles (f.o.b. refinery)	18.00	12.00
Maurer, N. J. (Bermudes)	.....	26.00
Maurer, N. J. (Trinidad)	.....	22.00
Minneapolis (f.o.b. Twin Cities)	21.30	16.30
Montreal (f.o.b. factory)	17.00	13.00
New Orleans (f.o.b. refinery)	16.00	12.00
New York	19.00	15.00
Philadelphia	17.00	11.00
Pittsburgh	25.00	16.00
St. Louis (f.o.b. refinery)	14.00	10.00
San Francisco (f.o.b. refinery)	16.00	10.00
Seattle	21.10	14.00

LIQUID ASPHALT — Residual, hot application, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Atlanta	$0.0539
Bayonne and Baltimore refineries	.05
Birmingham	.06
Boston	.055
Cincinnati	.075
Dallas	.05
Kansas City	.05
Los Angeles	.045
Montreal at (refinery)	.09
New York	.06
Philadelphia	.08
Pittsburgh	.05
St. Louis (at refinery)	.035

EMULSIFIED ASPHALT — For penetration and surface treatment, per gal.:

Boston, applied	$0.12
Cincinnati, f.o.b. refinery	.06
Los Angeles, applied	.11
Des Moines, applied	.12
New York, applied	.15
Philadelphia, applied	.13
Pitt burgh f.o.b. refinery	.04@.06
St. Louis, applied	.12
Seattle, f.o.b. refinery	.055

Iron and Steel

	Pittsburgh	Chicago	Birmingham	Cleveland
STRUCTURAL SHAPES AND PLATES, per 100 lb., base, carload lots	$1.60	$1.70	$1.75	$1.78
CONCRETE REINFORCING BARS, ¼ in., billet, per 100 lb., carload lots	1.60	1.65	1.75	1.50
SHEETS, per 100 lb., carload lots:				
Hot-rolled No. 10	1.55	1.65	1.85	.....
Hot-rolled annealed No. 24	2.15	2.30	2.35	.....
Galvanized No. 24	2.80	2.95	3.00	.....
TERNE PLATES, per package, I.C., 8-lb. coating, 20x28 in.	9.50	.....	.....	.....
RIVETS per 100 lb., ½ in., structural, carload lots	2.25	2.35	2.70	2.25
SHEETPILING, per 100 lb., base, carload lots	1.90	2.05	.....	.....
WIRE NAILS, per 100 lb., base, carload lots	1.95	2.00	2.40	1.95
HEAVY MELTING STEEL SCRAP, No. 1, per gross ton, at consuming point	9.75	6.75	7@7.50	7.00

TRIANGLE MESH—Plain, per 100 sq.ft., 4 in. x 8 in., in carload lots:

Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
032	22	$0.85	$0.86
049	28	1.07	1.10
068	35	1.30	1.34
093	45	1.68	1.72
126	57	2.08	2.13
153	68	2.47	2.54
180	78	2.84	2.92
245	103	3.75	3.84
287	119	4.34	4.35
3X	138	5.03	5.16
395	160	5.83	5.98
036P	17	.64	.66
053P	24	.91	.93

TRIANGLE MESH—*Continued:*

Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
072P	31	1.14	1.17
097P	40	1.48	1.51
049R	24	.91	.93
067R	31	1.14	1.17
089R	40	1.48	1.51

WIRE ROPE—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	25 %
Galvanized iron rigging and guy rope (add to list)	7½ %
Galvanized steel rigging and guy rope	12½ %
Plow steel round strand rope	40 %
"Special Steel" and extra strong cast steel, round strand rope	32½ %

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

EXPANDED METAL LATH—Per 100 sq.yd., painted, f.o.b., in carload lots 2.2 lb. per sq.yd., standard-mesh diamond lath:

Atlanta	$20.00*	Los Angeles	$17.00
Birmingham	17.00	New Orleans	20.00
Boston	15.00	New York	13.50
Chicago	10.60	Philadelphia	13.50
Cincinnati	11.00	Pittsburgh	13.50
Dallas	18.00	St. Louis	15.50*
Detroit	18.00*	San Francisco	17.00*
Kansas City	17.00*	Seattle	19.00

*Delivered.

STEEL FREIGHT RATES — Per 100 lb., effective Dec. 3, 1931, on finished steel products in the Pittsburgh District, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.; 40,000 lb. per car:

Atlanta, 36,000 lb.	$0.60	Detroit	$0.285
Baltimore	.29	Kansas City	.59
Birmingham	.60	New Orleans, 36,000 lb.	.69
Boston	.42	New York, 40,000 lb.	.35
Buffalo	.255	Pacific Coast, 60,000 lb.	1.17*
Chicago	.36	Philadelphia	.31
Cincinnati	.285	St. Louis	.41
Cleveland	.205	St. Paul	.60
Denver	.92	* All rail.	

Railway Materials and Supplies

STEEL RAILS — Per gross for, f.o.b.

	Pittsburgh	Birmingham	Chicago
Standard rails	$40.00	$40.00	$40.00
Light rails	32.00	32.00	34.00
Re-rolled rails	21@23	.....	27.00

RAILWAY TIES — Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$0.95	.....
	Pine, untreated	.85	.....
	Pine, creosoted	1.40	.....
New York	Long-leaf sap pine, untreated	.90	$1.10
	Dense yellow pine, untreated	.69	.80
Birmingham	White oak, untreated	.75	.95
	White oak, creosoted	1.35	1.45
	Southern pine, untreated	.35	.80
	Southern pine, creosoted	.95	1.35
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.15	1.50
Los Angeles	Fir, untreated	.47	....
	Fir, creosoted	1.20	....
Philadelphia	Red oak, untreated	.95	1.15
	Red oak, creosoted	1.47	1.90
St. Louis	White oak, untreated	.75	1.25
	Red oak, untreated	.70	1.05
	Red oak, creosoted	1.05	1.65
	Sap pine or cypress, untreated	.60	1.00
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

TRACK SUPPLIES — Prices per 100 lb., f.o.b., for carload lots:

	Pittsburgh	Birmingham	Chicago
Angle bars	$2.75	$2.75	$2.75
Standard spikes	2.60	2.40	2.60
Tie plates	1.85	1.85	1.85
Track bolts	3.50	3.50	3.50

Pipe

WROUGHT STEEL PIPE — Discounts from standard list for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 17c.; 3-in., 76½c.; 3½-in., 92c.; 6-in., $1.92.

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Atlanta	44%	36.5%	42%	34%
Boston	55.5%	42.25%	51.35%	40.1%
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
Denver	44.5%	32%	41%	28.5%
New York	56.14%	43.6%	52.72%	40.18%
Philadelphia	57.28%	44.68%	53.68%	41.80%
Pittsburgh	64%	52.5%	61%	49.5%
St. Louis	51%	38%	48%	35%

Current Prices of Construction Materials

Pipe—Continued

CAST-IRON PIPE— Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b. in carload lots; gas pipe and Class A, $3.00 per ton extra:

	4-In.	6-In. and Over
Atlanta	$37.50	$34.50
Boston	41.00	38.00
Birmingham (Base)	33.00	30.00
Burlington (Base)	35.00	32.00
Chicago	41.50	38.50
Dallas	45.50	42.50
Los Angeles	41.50	38.50
New York	38.50	35.50
Philadelphia	35.00	32.00
Pittsburgh	41.50	38.50
St. Louis	40.50	37.50
San Francisco	41.50	38.50

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.125	$0.21	$0.385	.....	$1.40.	.....	.....
Baltimore	.10	.30	.58	.....	1.93	.....	$6.50
Birmingham	.18	.30	.54	$1.02	1.95	$3.50	5.00
Boston	.16	.25	.50	1.25	2.10	4.40	5.50
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.0945	.....	.2835	.....	1.125	2.448	.....
Cleveland	.135	.21	.405	1.125	2.025	4.824	7.38
Dallas	.23	.....	.7165	.....	2.70	.....	.....
Denver	.16	.23	.414	.816	1.44	.....	.....
Detroit	.0855	.....	.2625	.....	1.90	3.80	.....
Kansas City	.21	.335	.52	1.00	1.90	3.80	.....
Los Angeles(f.o.b.)	.2175	.2825	.5085	1.1865	2.034	3.69	.....
Minneapolis	.18	.23	.46	1.20	1.85	3.20	4.26
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	.18	.30	.54	1.02	1.95	.....	.....
New York	.13	.21	.42	1.15	2.10	.....	.....
Philadelphia	.081	.126	.243	.65	1.17	2.376	4.615
Pittsburgh	.09	.18	.27	.62	1.22	2.45	3.68
St. Louis	.112	.210	.378	.945	1.62	3.20	4.40
San Francisco	.175	.25	.45	1.05	1.80	3.00	4.50
Seattle	.21	.30	.54	1.26	2.16	3.60	5.50

CLAY DRAIN TILE—Per 1,000 lin.ft., f.o.b., in carload lots, 4 in.:

Atlanta	$50.00	Los Angeles	$60.00
Birmingham	50.00	New Orleans	40.00
Boston	40.00	New York	35.00
Chicago	40.00	Philadelphia	36.00
Dallas	65.00	Pittsburgh	80.00
Denver	75.00	St. Louis	40.00
Detroit	40.00	San Francisco	67.50
Kansas City	70.00	Seattle	42.50

Miscellaneous

LINSEED OIL—Raw, in 5-bbl. lots, per lb., f.o.b.:

Atlanta	$0.08	Minneapolis	$0.076
Birmingham	.066	Montreal (per gal.)	.45
Boston (per gal.)	.50	New York	.072
Dallas (per gal.)	.555	Philadelphia	.064
Denver (per gal.)	.72	Seattle (per gal.)	.67
Kansas City (per gal.)	.51	St Louis	.08
Los Angeles	.0813	San Francisco (del)	.1125

WHITE LEAD—In oil, per 100 lb. keg., f.o.b.:

Atlanta	$12.50	Montreal	$ 8.20
Birmingham	12.50	New Orleans	11.00
Boston	11.50	New York	12.00
Dallas	14.00	Philadelphia	9.50
Kansas City	12.50	Seattle	11.00
Los Angeles	11.50	St. Louis	12.00

Note: Both white and red lead, dry, same prices as foregoing; red in oil, $1.50 higher.

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.75@2.00
Calcium chloride, 77-80%, flaked, in 400-lb. drums, f.o.b. works, per ton	21.00
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in bags, per 100 lb.	1.22½
Sulphate of aluminum, in bags, per 100 lb.	1.25@1.40
Sulphate of copper, in bbl., per 100 lb.	3.00

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¼-in., 6-ft., 1-in.; ½-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1½-in., 2-ft., 5-in.; 1¾-in., 1-ft., 8-in. Following prices are per lb. for ½-in. and larger, delivered in 1,200 ft. coils:

Atlanta	$0.174	Kansas City	$0.21
Baltimore	.225	Los Angeles	.1725
Birmingham	.20	Minneapolis	.175
Boston	.16	Montreal	.1625
Chicago	.175	New Orleans	.175
Cincinnati (f.o.b.)	.21	New York	.16
Cleveland	.21	Philadelphia	.15
Dallas	.18	St. Louis	.155
Denver	.18	San Francisco	.155
Detroit	.185	Seattle	.155

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point $2.40

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.70

PREPARED ROOFING—Per square, f.o.b., in carload lots:

	Single Shingles*	Strip Shingles†	Rolls‡
Atlanta	$5.85	$6.25	$2.05
Boston	6.25	6.00	2.50
Dallas	4.50	3.60	1.90
Detroit	6.25	6.50	1.85
Montreal	6.40	6.20	2.68
New Orleans	5.60	5.50	2.00
New York	6.50	6.25	2.50
Philadelphia	4.40	4.20	1.60
Seattle	8.75	5.50	2.25
St. Louis	5.18	6.24	1.89

*Slate finish, sufficient to cover 100 sq.ft. ‡Slate surfaced, in rolls weighing 85 to 90 lb. †4 in 1, hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—In carload lots, f.o.b.:

	Asphalt Felt, per 100 Lb.	Tar Felt, per 100 Lb.	Asphalt Coating, per Gal.	Tar Pitch,* per Ton
Atlanta	$44.50†	$44.50†	$0.45	$44.50
Boston	2.40	2.40	0.33	28.00
Dallas	3.17	5.00	.75	38.00
Denver	2.00	2.00	.90	18.00
Montreal	2.62‡	2.02‡	1.40	1.63**
New Orleans	.....	2.50	.....	22.50
New York	2.40	2.40	.34‡	28.00
Philadelphia	2.25	2.25	.33	20.00
Seattle	2.40	2.40	.55	27.90

*In 350 lb. barrels. †Per ton. ‡Per roll. **Per English cwt.

WINDOW GLASS—Discounts from latest jobbers list, dated Sept. 15, 1928 for sizes above first three brackets:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
Atlanta	85%	85%	85%	85%
Birmingham	89%	91%	89%	91%
Boston	88%	90%	87%	89%
Dallas	85%	85%	85%	85%
Denver	84@5%	86@5%	84@5%	86@5%
Kansas City	90@5%	90@5%	90@5%	90@5%
New York	87%	89%	87%	89%
Philadelphia	88%	90%	88%	90%
Pittsburgh	87%	89%	87%	89%
Seattle	90@10%	90@20%	90@10%	90@20%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.215	$0.2375	Los Angeles	$0.145	$0.165
Baltimore	.21	.255	Minneapolis	.18	.195
Birmingham	.13	.1525	Montreal	.1675	.1925
Boston	.225	.25	New Orleans	.19	.22
Chicago	.17	.195	New York	.245	.2675
Cincinnati (f.o.b.)	.22	.245	Philadelphia	.215	.24
Dallas	.22	.24	St. Louis	.145	.165
Denver	.19*	.21*	San Francisco	.1575	.1825
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*F.o.b Louviers.

Lumber

LUMBER—Per M. ft., b.m., No. 1, Common, rough, in carload lots:

SOUTHERN L. L. YELLOW PINE

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x12 In.† F.o.b.
Atlanta	$14.00	.....	$15.00	.....	$35.00	.....	$45.00
Baltimore	.....	$46.00	.....	$43.00	.....	$42.00	35.00
Birmingham	.....	15.00	.....	15.00	.....	18.00	25.00
Boston	27.00	32.00	29.00	34.00	45.00	50.00	65.00
Chicago	.....	.....	.....	.....	.....	62.50	.....
Cincinnati	.....	28.00	.....	28.00	.....	35.00	35.00
Cleveland	30.00	38.00	32.00	40.00	46.00	54.00	.....
Dallas	.....	27.50	.....	27.50	.....	52.50	52.50
Denver	.....	31.00	.....	33.00	.....	45.00	.....
Detroit	30.00	32.00	30.00	32.00	32.00	32.00	45.00
Kansas City	24.00	.....	21.00	.....	46.00	.....	.....
Minneapolis	.....	31.00	.....	31.00	.....	34.00	.....
Montreal	44.00	.....	45.00	.....	30.00	.....	.....
New Orleans	.....	17.00	.....	18.00	.....	50.00	.....
New York	22.00	24.00	23.00	25.00	50.00	52.50	50.00
Phil. No. 2(com.)	19.00	23.00	20.00	24.00	29.00	33.00	44.00
Pittsburgh	20.00	33.00	20.00	33.00	32.00	39.00	46.00
St. Louis	23.50	28.50	23.50	28.50	45.00	50.00	43.00

DOUGLAS FIR

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x12 In.† F.o.b.
Baltimore	.....	$48.00	.....	$52.00	.....	$58.50	$70.00
Boston	$25.00	30.00	$27.00	32.00	$31.00	36.00	43.00
Chicago	.....	.....	.....	.....	.....	44.52	.....
Cincinnati	.....	.....	.....	.....	.....	42.50	42.50
Cleveland	30.00	38.00	32.00	40.00	40.00	54.00	.....
Denver	31.00	.....	33.00	.....	46.00	.....	50.00
Detroit	.....	.....	.....	.....	30.00	30.00	45.00
Kansas City	30.00	.....	33.00	.....	42.00	.....	39.00
Minneapolis	.....	31.00	.....	31.50	.....	36.00	.....
New Orleans	.....	21.00	.....	21.00	.....	42.50	.....
New York	19.00	21.00	20.00	22.00	22.50	24.50	24.00
Philadelphia	.....	.....	.....	.....	.....	28.00	30.00
Pittsburgh	.....	.....	.....	.....	58.00	63.00	48.00
St. Louis	30.50	35.50	30.50	35.50	31.00	36.00	31.00
San Francisco	.....	15.00	.....	16.00	.....	17.00	17.00
Seattle	9.00	11.00	11.00	13.00	12.00	14.00	15.00

*Form lumber, 16 ft. lengths. †Planks and timbers, 20 ft. lengths.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.195
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
in.—2 ft. from butt	5 in.	85 to 89 ft.	.305	.442